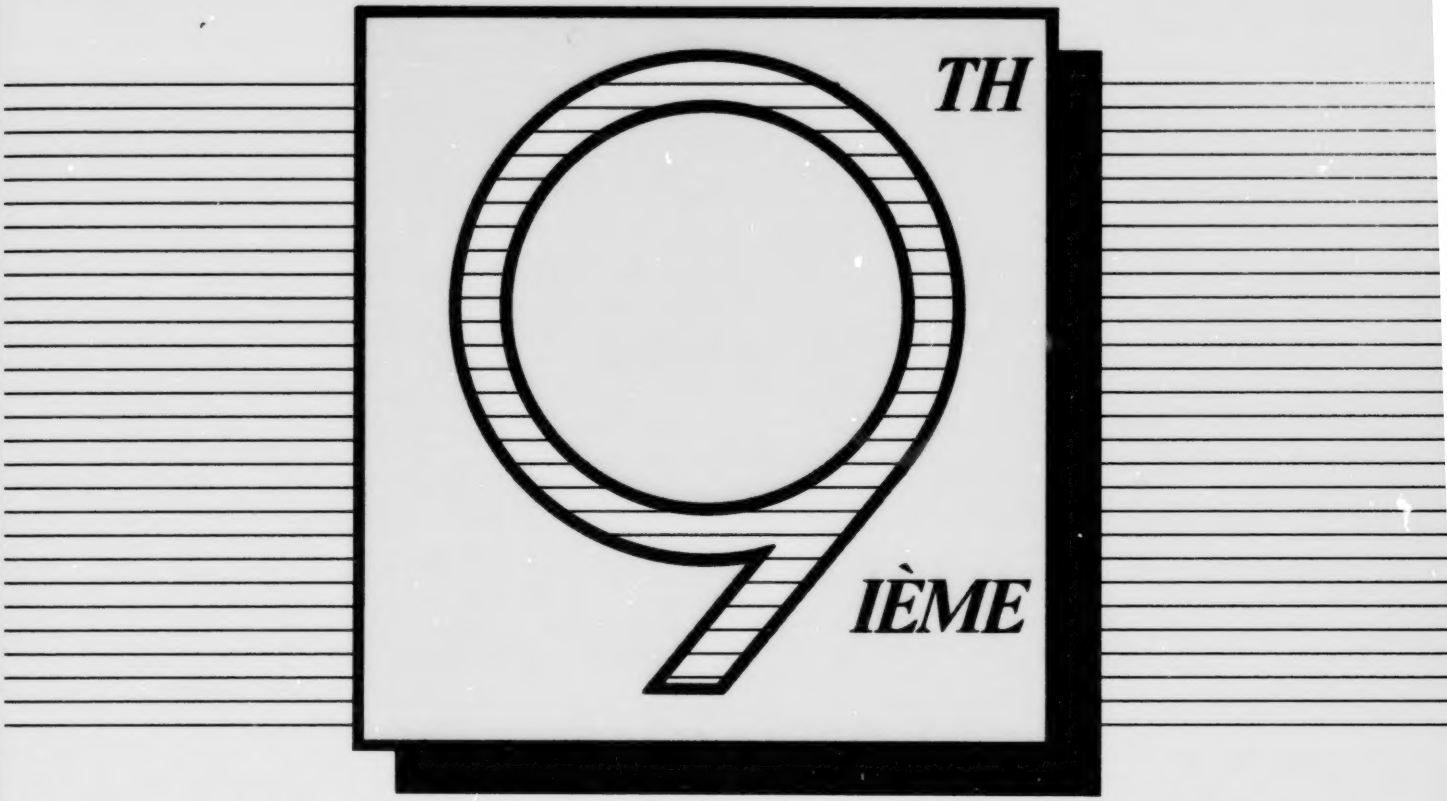
# PROCEEDINGS • COMPTES RENDUS



# Canadian Conference On Waste Management

# Conférence canadienne sur la gestion des déchets

**October 7-9, 1987**
**Edmonton**

**7 au 9 octobre 1987**
**Edmonton**

Environment Canada
Environnement Canada

Canada

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PROCEEDINGS

COMPTES RENDUS

# 9th CANADIAN WASTE MANAGEMENT CONFERENCE

# 9ième CONFÉRENCE CANADIENNE SUR LA GESTION DES DÉCHETS

October 7-9, 1987
Westin Hotel
Edmonton

Les 7,8 et 9 octobre 1987
Hôtel Westin
Edmonton

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The steering Committee of the 9th Canadian Waste Management Conference in Canada wishes to record it's appreciation of the efforts of the panelists for preparing the outlines of their papers and their subsequent delivery and to the panel moderators for guiding panelists and audience during the conference sessions.

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Le comité d'organisation de la 9ième Conférence canadienne sur la gestion des déchets aimerait noter son appréciation auprès des conférenciers pour la préparation de leur présentation ainsi qu'aux modérateurs pour leur aide soutenue lors du déroulement de la conférence.

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# CANADIAN COUNCIL OF RESOURCE AND ENVIRONMENT MINISTERS (CCREM) ACTION PLAN FOR THE MANAGEMENT OF HAZARDOUS WASTES IN CANADA

L. HUBBARD, B.C. Ministry of the Environment

## INTRODUCTION:

In Canada, hazardous wastes are being managed in a manner that could pose a significant danger to public health and the environment. This has occurred as a result of inadequate and inconsistent application of legislation across the country and the lack of proper disposal facilities.

The national scope of this issue requires the co-operative and concerted effort of all sectors of society, including the various levels of government, industry and the general public. Under the leadership of the Canadian Council of Resource and Environment Ministers (CCREM), an Action Plan has been developed which will provide the cornerstone of an effective hazardous waste management program in this country.

## THE PLAN:

Following a CCREM policy decision in 1985, an Action Plan was developed for dealing with hazardous waste in a co-ordinated manner across Canada.

The Action Plan, approved in October 1986,is designed to:

- Promote co-operative efforts among the Provincial and Federal jurisdictions for dealing with the various facets of the hazardous waste issue. It is intended to reduce potential overlaps in areas such as research and promote sharing of critical information on all phases of this complex issue so as to protect public health and the environment in a more effective way.
- Harmonize hazardous waste legislation and programs both among the Provinces and internationally with our major trading partners.
- Foster a more co-operative approach among the various jurisdictions and agencies regarding the establishment and use of centralized waste treatment and disposal facilities.
- To improve the public's understanding of their role in this societal issue, one that will become more and more important in the years ahead as a result of population and technological growth.

**EXPECTED RESULTS:**

CCREM, with the assistance of a consultant, will be tracking the progress of the plan right through to completion.

The expected outputs will benefit all Canadians and will include:

- A framework to ensure that the management of hazardous wastes across Canada is brought under control and that realistic public expectations can be fulfilled by governments and industry;
- Increased implementation of hazardous waste reduction and recycling initiatives by industry;
- The development and implementation by all jurisdictions of a uniform national definition of hazardous waste and standards for future revisions of the hazardous waste list;
- A co-operative interjurisdictional approach towards the establishment and use of centralized hazardous waste management facilities;
- Development and adoption of national codes of good practice for waste management by all jurisdictions;
- The identification of a program to address active and closed hazardous waste sites and sites contaminated by hazardous materials which impact adversely on environmental quality, including a study of the feasibility of establishing a national contingency fund which could become an integral part of the program; and
- The enhancement of the public's perception of the manageability of the problem through implementation of a joint federal/provincial communication strategy.

A more detailed version of the plan, identifying specific activities, is attached.

## CANADIAN COUNCIL OF RESOURCE AND ENVIRONMENT MINISTERS

# ACTION PLAN
# FOR
# THE MANAGEMENT OF HAZARDOUS WASTE

FEBRUARY 1987

### CANADIAN COUNCIL OF RESOURCE AND ENVIRONMENT MINISTERS
### ACTION PLAN FOR
### THE MANAGEMENT OF HAZARDOUS WASTE

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 1. **WASTE DEFINITION UNIFORMITY**<br>**ESTABLISH A STANDARDIZED NATIONAL DEFINITION OF HAZARDOUS WASTE TO COVER BOTH TRANSPORTATION AND WASTE MANAGEMENT NEEDS.** |  | Presently a variety of hazardous waste definitions exist. A national framework within which provinces can meet their own needs is required while at the same time ensuring consistency with others. The completed action item would provide uniformity in defining hazardous waste for purposes of federal and provincial waste management and transportation legislation and regulations. |
| Activities |  |  |
| 1.1 Review legislation, regulations, guidelines and codes across Canada, as related to the definition of hazardous waste, to identify differences and common elements. | Waste Committee<br>Transport of Dangerous Goods (TDG) Working Group<br>(All Jurisdictions) | Hazardous Waste Definition Comparison table has been prepared by Environment Canada providing an overview of the differences and common elements in the regulations used across Canada.<br>Report to be prepared to examine in detail the approaches to defining hazardous waste used across Canada. This report will identify differences and common elements and present options for arriving at a national system. |
| 1.2 Develop national criteria for defining and listing of hazardous waste. | Waste Committee<br>TDG Working Group<br>(All Jurisdictions) | Amendments to the Federal Transportation of Dangerous Goods (TDGA) Regulations have been proposed to Transport Canada addressing interim national criteria list and Ontario's leachate schedule. A number of projects to support national criteria are underway. This will result in a |

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 1.2 (Continued) | | document outlining national criteria for defining and listing hazardous wastes. |
| 1.3 Develop or improve testing protocols. | Waste Committee<br>TDG Working Group<br>(All Jurisdictions) | The development of test protocols in support of the national criteria to be finalized by March 1989. Their refinement will be an ongoing activity based on new knowledge and experience with test procedures. |
| 1.4 Develop uniform waste identification (numbering) system for transportation and waste management. | Waste Committee<br>TDG Working Group<br>(All Jurisdictions) | Developed in conjunction with 1.2 above. |
| 1.5 Establish the means by which criteria, lists and processes may be developed and maintained to ensure the continuation of a uniform hazardous waste definition. | Waste Committee<br>(All Jurisdictions) | Once activities 1.1 through 1.4 have been completed it will be necessary to address the means by which national uniformity will be maintained. The decisions and timing will be dependent on the outputs of 1.2 and 1.4. |
| 1.6 Make amendments to the Federal Transportation of Dangerous Goods Act (TDGA) and regulations and respective provincial legislation. | (All Jurisdictions) | Amendments to transportation and waste management legislation and regulations will require implementation by individual jurisdictions on an ongoing basis to ensure uniformity consistent with outputs of activities 1.2, 1.3, 1.4 and 1.5. |

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 2. **HAZARDOUS WASTE FACILITIES** | | |
| **ESTABLISH NATIONAL GUIDELINES FOR A RANGE OF HAZARDOUS WASTE MANAGEMENT FACILITIES TO ENSURE PROTECTION OF THE NATURAL ENVIRONMENT AND PUBLIC HEALTH IN CANADA.** | | National guidelines will be developed which all governments can utilize, to establish standards for storage, treatment and disposal facilities within their jurisdiction. |
| Activities | | |
| 2.1 Develop national guidelines for: | | |
| (a) Incineration | Ontario | Development of design criteria and operating, monitoring, maintenance and emergency shutdown requirements will be undertaken for both high and low temperature incineration of hazardous waste (including biomedical wastes and PCBs). |
| (b) Physical/Chemical Treatment | Alberta | Development of operating, maintenance, emergency shutdown, monitoring and contingency requirements will be undertaken. |
| (c) Landfill | Environment Canada | Development of design criteria, operating, monitoring and closure requirements will be undertaken. |

# CANADIAN COUNCIL OF RESOURCE AND ENVIRONMENT MINISTERS
# ACTION PLAN FOR
# THE MANAGEMENT OF HAZARDOUS WASTE

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 2.2 Establish codes of practice for industrial sectors and/or waste types. | | National codes of practice will assist governments, waste generators, treaters and disposers of wastes to assess specific waste management options. This activity will be initiated when other key action plan items are complete. In a number of instances implementation of this activity may be combined with activity 7.3 of this Action Plan leading to a comprehensive code. |
| 2.3 Review regulatory requirements in all provinces relating to the approval of mobile waste management facilities and recommend an approach to facilitate the co-operative use of such facilities. | Environment Canada | The use of mobile facilities to treat, reduce or destroy hazardous waste is seen as a promising and emerging methodology. It will be very beneficial to ensure developments in this field can be readily adapted to use in all Canadian jurisdictions on a co-operative basis. |
| 2.4 Determine means of collectively managing hazardous waste from small generators. | British Columbia | Most environmental legislation provides for exemptions from various controls for small quantities of industrial and commercial hazardous wastes. Nevertheless, it is recognized that these wastes collectively may pose environmental problems and unique approaches may be required to address their management. A report will be produced that will make recommendations for dealing with this issue. |

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 3. **REGULATORY RESPONSIBILITIES OF GENERATORS, CARRIERS AND RECEIVERS** | | |
| **ESTABLISH UNIFORMITY IN ADDRESSING ROLES AND RESPONSIBILITIES OF HAZARDOUS WASTE GENERATORS, TRANSPORTERS, RECYCLING, TREATMENT, STORAGE AND DISPOSAL OPERATORS.** | | A uniform approach is required to prevent "pollution havens" and provide for transboundary commerce in waste management. |
| Activities | | |
| 3.1 Review legislation, regulations, guidelines and codes as they apply to the permitting, licensing, certification, or control of those generating, transporting, treating, storing or disposing of hazardous waste to identify differences and common elements. | Environment Canada | There are significant differences amongst the jurisdictions in the requirements they place on the various parties involved in generating and managing wastes. As a basis for establishing a degree of uniformity, it is necessary that a complete review of existing practices be undertaken and documented. All matter of instruments that can dictate requirements must be considered including legislation, regulations, criteria, guidelines, objectives and policies. |
| 3.2 Establish uniform responsibilities for:<br>1) waste generators;<br>2) haulers; and<br>3) receivers. | | Based on the results of 3.1, a report will be produced that will analyze options for moving towards uniform requirements for waste generators, transporters and receivers and make recommendations on action required. Agreement on minimum requirements will improve confidence in the effectiveness |

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 3.2 (Continued) | | of controls to protect the environment across Canada, particularly where transboundary commerce takes place for the management of hazardous waste. |

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 4. DECOMMISSIONING REQUIREMENTS<br>**ESTABLISH UNIFORM APPROACHES ON DECOMMISSIONING INDUSTRIAL PLANTS, STORAGE FACILITIES AND WASTE DISPOSAL SITES.** |  | Regulatory authorities have been faced with an increasing number of issues concerning remedial measures for abandoned hazardous waste disposal and storage sites. These sites may pose a threat to the environment and the establishment of criteria to ensure adequate clean-up is therefore required. Industrial operations undergoing decommissioning, for example, should meet criteria compatible with future land use. To date these requirements have largely been met by ad hoc processes addressing each need on its own merits. |
| Activities |  |  |
| 4.1 Develop action level criteria and criteria for clean-up of contaminated sites including waste disposal and storage, industrial and commercial sites being decommissioned, taking into consideration site specific conditions such as proposed and future land use. | Environment Canada/ Quebec | A report will be produced that will address specific contaminants typically found at waste storage and disposal sites, or sites used for industrial operations, that are of environmental or public health significance. The report will identify a method for establishing clean-up criteria for these contaminants at varying levels depending on future use of the site. Future use could include development for agricultural, industrial or residential purposes. Another report will identify action level criteria. |

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 4.2 Develop national guidelines that would address the necessary steps, considerations and activities involved in decommissioning an industrial facility to meet site clean-up criteria. | Environment Canada | In order to arrange for the orderly decommissioning of an industrial site and facilitate the meeting of clean-up criteria, there are a number of elements that must be addressed in an appropriate decommissioning plan. A guideline will be produced that will identify these elements and methodologies to achieve the required end point. |
| 4.3 Develop a guideline for decommissioning waste disposal sites that would address the necessary steps, considerations and activities involved in such a process. | Quebec | The decision to clean-up a waste disposal site is often directly related to its level of impact on the nearby inhabitants and local environment. Clean-up criteria will be established that when met will minimize or eliminate any adverse impacts on public health or the environment. A guideline will be produced that will identify the different steps that must be followed in arriving at a decision regarding waste disposal site clean-up. |
| 4.4 Recommend uniform implementation strategy for site decommissioning. | | Using the output of 4.1, 4.2 and 4.3, alternate strategies for ensuring the establishment of controls over decommissioning and site clean-up will be developed and recommendations presented. These strategies will consider legislative, regulatory and policy initiatives that may be required to gain an acceptable level of control in these areas. |

## CANADIAN COUNCIL OF RESOURCE AND ENVIRONMENT MINISTERS
## ACTION PLAN FOR
## THE MANAGEMENT OF HAZARDOUS WASTE

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 5. **INTERJURISDICTIONAL HARMONIZATION OF WASTE MANAGEMENT CONTROLS**<br>**WORK TOWARDS INTERNATIONAL AND NATIONAL HARMONIZATION OF HAZARDOUS WASTE PROGRAMS AND CONTROLS.** | | Sharing of hazardous waste management facilities may often be the more cost effective and environmentally superior alternative for handling certain hazardous wastes.<br>Resistance exists to transboundary movement of hazardous waste for purposes of treatment, destruction and disposal. If issues such as harmonization of controls and sharing of risks can be resolved, then there may be less reluctance to share facilities leading to optimum use of often very costly technology. |
| Activities | | |
| 5.1 Establish international hazardous waste definitions including listing criteria and testing protocols. | Environment Canada | A Council decision of the Organization for Economic Co-Operation & Development (OECD) has resulted in the establishment of working definitions and an agreed upon list of hazardous wastes. Implementation of these will start in 1988. Environment Canada will continue to monitor international developments in this area and ensure Canadian interests are accommodated. |

# CANADIAN COUNCIL OF RESOURCE AND ENVIRONMENT MINISTERS
# ACTION PLAN FOR
# THE MANAGEMENT OF HAZARDOUS WASTE

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 5.2 Work toward the establishment of a uniform international manifest. | Environment Canada | OECD manifest system is being developed and will be finalized by December 1987 for implementation in 1988.<br>Environment Canada will continue its efforts with the United States Environmental Protection Agency to develop a uniform manifest system for Canada/U.S. shipments. |
| 5.3 Develop international pre-notification protocols. | Environment Canada | Canada/U.S. pre-notification system has been developed and implemented.<br>OECD pre-notification system is expected to be finalized by December 1987. |
| 5.4 Arrange appropriate bilateral and multilateral agreements governing transboundary movement of hazardous wastes. | | PCB pre-notification and inspection requirements have been proposed as amendments to the Transportation of Dangerous Goods Act regulations for transboundary movements of PCBs within Canada.<br>An agreement has been executed between Canada and the United States concerning movement of hazardous wastes between the two countries. OECD multi-lateral agreement to be finalized by Dec./87. |
| 5.5 Review the rationale and practices of all provinces regarding acceptance of interprovincial shipments of hazardous wastes. | | Action has been deferred on items 5.5, 5.6 and 5.7 while effort is directed to other key action plan items. These activities will be initiated at an early date and will likely take on |

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 5.5 (Continued) | | prominence as individual jurisdictions establish more hazardous waste management facilities. |
| 5.6 Recommend approaches to achieve transboundary movement of hazardous waste for treatment and disposal. | | |
| 5.7 Evaluate alternative approaches for distribution of short and long-term costs associated with establishing and operating treatment, storage and disposal facilities which handle waste generated in a number of jurisdictions. | | |

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 6. **PROGRAM TO ADDRESS SITES CONTAMINATED BY HAZARDOUS MATERIALS** | | |
| **A NATIONAL PROGRAM IS REQUIRED TO ADDRESS REMEDIAL ACTION AT CONTAMINATED SITES THAT POSE A THREAT TO PUBLIC HEALTH OR THE ENVIRONMENT.** | | Problems often arise when environmental threats are discovered involving sites contaminated with materials whose owners or responsible parties are either unknown, or when known, do not have resources necessary for remedial action. Similar problems can arise with incidents resulting from spills or mismanagement of hazardous materials, where the responsible party is unknown, has insufficient resources or denies responsibility for the incident. A plan that addresses the administrative, technical and fiscal requirements to deal with these situations on a national scale, is desirable. |
| Activities | | |
| 6.1 Develop an inventory of known problem sites contaminated by hazardous materials. These would include:<br>1) hazardous waste management sites;<br>2) sites involving historical spills;<br>3) storage sites involving mismanagement of hazardous materials; | All Provinces/Waste Committee | Not all known problem sites are of the same environmental priority or urgency with respect to implementation of remedial action. An inventory accompanied by a systematic prioritization and an estimate of costs for remedial action is essential to determine the national scope of the problem, assess fiscal needs to address the issue and develop administrative procedures. |

## CANADIAN COUNCIL OF RESOURCE AND ENVIRONMENT MINISTERS
## ACTION PLAN FOR
## THE MANAGEMENT OF HAZARDOUS WASTE

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 6.1 (Continued)<br>4) abandoned industrial and municipal sites involving hazardous materials or wastes. | | |
| 6.2 Conduct a feasibility study and develop proposals for a national contingency fund to finance remedial activities. | Environment Canada | A report will be provided to Ministers by Oct./87 and it will outline the scope and mechanisms available for the establishment of a national environmental contingency fund. |
| 6.3 Develop a program for environmental remedial action at problem sites contaminated with hazardous materials. | | This program will be developed following the analysis of the findings and outputs of tasks 6.1 and 6.2 and may provide alternate mechanisms depending on the nature of the site. |

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 7. **HAZARDOUS WASTE REDUCTION, RE-USE, RECYCLE, RECOVERY**<br>**IDENTIFY AND DEVELOP MECHANISMS TO MAXIMIZE THE REDUCTION, RE-USE, RECYCLE AND RECOVERY OF HAZARDOUS WASTE.** | | The Reduction, Re-use, Recycle and Recovery (4R's) of hazardous wastes, represent preferred waste management alternatives when compared to treatment and destruction. While much has been accomplished by applying 4R's strategies (i.e. Canadian and Provincial waste exchanges, recycling of spent solvents, combustion with energy recovery, re-refining of lubricating oils), additional efforts are required to take maximum advantage of potential opportunities. |
| Activities | | |
| 7.1 Identify barriers that impede hazardous waste reduction, re-use, recycle and recovery and recommend ways to remove or mitigate these obstacles. | British Columbia | A report will be produced that will identify and document barriers to the minimization of hazardous wastes through application of 4Rs strategies. The report will examine economic, technical, market and legislative barriers. An assessment of informational needs, research, economic incentives, markets and regulatory change required to enhance waste management opportunities through the 4R's will be provided. |

CANADIAN COUNCIL OF RESOURCE AND ENVIRONMENT MINISTERS
ACTION PLAN FOR
THE MANAGEMENT OF HAZARDOUS WASTE

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 7.2 Conduct a review of waste exchange programs in Canada, U.S. and abroad and evaluate ways and means of expanding the use and productivity of this mechanism on a national basis. | British Columbia | A report will be produced that will examine the use of waste exchanges to reduce the quantity of hazardous wastes requiring treatment and disposal. All known existing waste exchanges will be analyzed and features that optimize the achievements of such exchanges will be highlighted. The report will identify the opportunities for maximizing the use of waste exchanges in Canada and outline technical, legal and informational requirements to enhance existing or put in place new waste exchange programs that are most effective. |
| 7.3 A technical manual series will be developed for targetted specific hazardous waste streams that will identify opportunities for reduction, re-use, recycle or recovery of these wastes. It is anticipated that the series will be developed at the rate of about 2 manuals per year. | Waste Committee (All Jurisdictions) | Manuals will be prepared on the basis of priorities assigned by the Canadian Council of Resource and Environment Ministers Toxic Substances and Waste Management Advisory Committee. They will be targetted for those waste streams of greatest national concern or interest. They will be made available to the appropriate industrial sectors to assist them in identifying opportunities and options for reducing the quantity of hazardous wastes that require treatment or disposal. In a number of instances, development of these manuals may be combined with activity 2.2 of this action plan leading to a comprehensive manual that will address all waste management alternatives and outline a code of practice. |

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 7.4 Identify opportunities to use existing "employment enhancement programs" to assist in the reduction of hazardous wastes and identify potential for expansion or enhancement of such programs on a national basis. | British Columbia | Initiatives to enhance employment opportunities for the disadvantaged, unemployed technical and professional graduates or for areas of high unemployment, usually developed by the Federal Department of Employment and Immigration, have been used in some instances in the past to promote environmental goals and objectives. A review of the use of such programs to promote reduction of hazardous wastes or otherwise improve hazardous waste management will be undertaken and documented. Recommendations will be made as to how greater use of such programs might be achieved through expansion, training, cost sharing (industry and governments) or other means. |

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| **8. INFORMATION EXCHANGE AND PUBLIC COMMUNICATIONS** | | |
| **IMPROVE AND EXPAND DATA AND INFORMATION ON THE QUANTITIES, TYPES, MANAGEMENT OPTIONS AND POTENTIAL EFFECTS OF HAZARDOUS WASTES GENERATED IN CANADA.**<br>**DEVELOP STRATEGIES TO IMPROVE PUBLIC UNDERSTANDING OF THE MANAGEMENT OF HAZARDOUS WASTE.**<br>**MAKE AVAILABLE TO PUBLIC ON CONTINUING BASIS CREDIBLE INFORMATION ON HAZARDOUS WASTE MANAGEMENT (SOURCES, RISKS, CONTROL MEASURES).** | | Today's high speed communication networks bring issues of concern to everyone's attention almost simultaneously. Co-ordination of effort to inform the public of hazardous waste management issues can optimize use of resources, ensure timely and accurate messages and optimize knowledge base from which to draw information and expertise. A strategy, suitable for application to a wide variety of waste management issues will be developed and applied on the basis of national priorities. When specific issues are identified, projects will be assigned to appropriate communications and technical experts for implementation.<br>Sharing of resources and knowledge is essential to improvement in the reliability and availability of technology for hazardous waste management.<br>Research co-ordination on a national scale is required to address high priority issues in a cost effective and efficient manner. |

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| **Activities** | | |
| 8.1 Evaluate alternate approaches to the establishment and maintenance of a national hazardous waste data base and recommend a system that will benefit waste management activities across Canada. | Environment Canada | Individual jurisdictions have undertaken many hazardous waste management initiatives in recent years. This has led to the production of data and information necessary to improve understanding of the scope of the hazardous waste issues. There is a need now to arrange for the systematic sharing of this data or information. A national system to accomplish this is desirable and would assist jurisdictions in establishing strategic priorities, identify emerging issues and record accomplishments and new initiatives across Canada. Environment Canada will determine the type of data available, information gaps, data analysis requirements and make recommendations for the implementation of a national data base and information system which would be accessible to a variety of users. |
| 8.2 Review current research needs and activities specific to the management of hazardous wastes and make recommendations to the CCREM Research Advisory Committee. | Waste Committee (All Jurisdictions) | Research is very often required before problems can be fully assessed and solutions developed and implemented. Research is often expensive and, if sharing of information on completed research, new initiatives and research needs is not extensive, then there is significant risk of duplication of effort, absence of important research |

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 8.2 (Continued) | | initiatives and inequitable funding of research. The Canadian Council of Resource and Environment Ministers (CCREM) will ensure that hazardous waste research activities are monitored and needs are identified and addressed. This is viewed as an ongoing responsibility. |
| 8.3 Compile inventory of hazardous waste issues and prioritize for targetted information program development. | New Brunswick | A national inventory of hazardous waste issues will be developed based on suggestions from all jurisdictions and priorities will be assigned. This will provide the basis for a public information program providing credible and timely information drawn from nation-wide experience and expertise on key hazardous waste issues having national significance. |
| 8.4 Develop information bulletins for specific issues and audiences. | | Using the output of activity 8.3, it is the intention to put together on an "as needed" basis, teams comprising communication and technical expertise, to arrange for the production and dissemination of public materials such as fact sheets, news releases and bulletins to inform the public on hazardous waste issues. This activity will not commence until activities identified in 8.3 have been completed and assessed. |

| ACTION ITEMS | RESPONSIBILITY | COMMENTS |
|---|---|---|
| 8.5 Develop specific awareness programs through appropriate media. | | It is the intention to proceed with additional CCREM public information initiatives after other key elements of this Action Plan are completed. At that time, attention will be directed to assessing the need for and developing other hazardous waste awareness programs and the identification of preferred formats and media to ensure the most effective dissemination of hazardous waste information to a variety of audiences. |

**LEGEND**

**CCREM**
- Canadian Council of Resource and Environment Ministers

**Toxic Substances & Waste Management Advisory Committee (TSWMAC)**
- A CCREM committee with membership drawn from the CCREM member jurisdictions generally at the Assistant Deputy Minister level.

**Waste Committee**
- A sub-committee of the TSWMAC with membership largely of Directors having responsibility for waste management in their jurisdictions.

**Waste Committee Transport of Dangerous Goods Working Group**
- A working group that reports to the Waste Committee with membership comprising waste management experts drawn from government and industry.

# CONSULTATIVE APPROACH TO DEVELOPMENT OF GUIDELINES AND REGULATIONS IN HAZARDOUS WASTE IN ALBERTA

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## ABSTRACT

In the Spring of 1985, the Minister of Environment established an Advisory Committee to advise him on the content, administration, application and enforcement of the Alberta Hazardous Chemicals Act and associated regulations and guidelines.

The Advisory Committee has expertise drawn from 17 major organizations with representation from the chemical, petroleum, mining and transportation industries, utilities and agriculture, and from others such as environmental groups, occupational health and municipalities. Alberta Environment (the regulatory authority) was included only as a resource to the Committee.

Subcommittees of the Advisory Committee reviewed the existing Hazardous Chemicals Act and studied in detail the 1985 Alberta Hazardous Waste Regulation and, through discussion, reached consensus on major recommended changes that were voted on and adopted by the Advisory Committee. These discussions generally resulted in consensus, with only a few contentious points deferred for further study by the sub-committees.

Advisory Committee members also participated in a number of Working Groups set up to 'fast track' the development of various elements in a comprehensive Hazardous Waste Management Implementation Program to be in place by the time the Alberta Special Waste Treatment Centre was opened.

The operation of the Advisory Committee and the influence of its recommendations on Alberta hazardous waste regulations and guidelines illustrate the effectiveness of the consultative approach involving the major stakeholders.

## 1.0 INTRODUCTION

The Alberta Provincial Department of the Environment uses the consultative approach in the development of regulations and guidelines relating to hazardous waste management in Alberta. This is an on-going process started a number of years ago and re-emphasized in the spring of 1985 when the Minister of Environment established an Advisory Committee to advise him on the content, administration, application and enforcement of the Alberta Hazardous Chemicals Act and associated Regulations and Guidelines. (This was two and one half years before the official opening of the Alberta Special Waste Treatment Centre at Swan Hills, Alberta on September 11, 1987).

The Advisory Committee was set up in accordance with the Hazardous Chemicals Act, with the mandate to advise the Minister on any aspect of the Hazardous Chemicals Act, including Regulations and Guidelines under the Act.

The Hazardous Chemicals Act (Consolidated May 2, 1985) Clause 5(1) states as follows:

> "The Minister shall appoint a Hazardous Chemicals Advisory Committee
>
> (4) The Committee shall
>
> (a) advise the Minister with respect to the content, administration, application and enforcement of this Act and the regulations.

## 2.0 COMPOSITION OF THE ADVISORY COMMITTEE

The Advisory Committee comprises only representatives from organizations and not individuals in their own right, and all committee members were personally appointed by the Minister of Environment. A list of the organizations represented on the Advisory Committee is presented in Table 1.

The Advisory Committee has expertise drawn from 17 major organizations with representation from the chemical, petroleum, mining and transportation industries, utilities and agriculture, and from others such as environmental groups, occupational health and municipality associations.

The Alberta Special Waste Management Corporation has a representative on the Advisory Committee. The Corporation is jointly responsible with Bow Valley Resources Services Ltd. for the Special Waste Treatment Centre in Swan Hills.

The Provincial regulatory authority, Alberta Environment, is not represented on the Advisory Committee; senior personnel from the Department attend Committee meetings at the Committee's request and provide an invaluable resource to the Committee.

## 3.0 OPERATION OF THE ADVISORY COMMITTEE

### 3.1 Mandate

The initial mandate of the Advisory Committee was to provide the Minister of Environment with recommendations on the Hazardous Waste Regulation 49/85 dated March 13, 1985 and on guidelines for the management of hazardous waste in Alberta, issued from time to time by Alberta Environment.

In reviewing the consultative process, the operation of the Advisory Committee may be viewed within the historical context of the development of guidelines and regulations for hazardous waste in the Province of Alberta. It is noted that the Advisory Committee does not formulate regulations or guidelines; these are the responsibility of the Department.

In May 1984, the Department of Environment issued a Guideline Document titled, "Administrative Procedures, Guidelines and Regulations for Management of Hazardous Waste in Alberta." It included the following topics:

- Administrative procedures
- Guidelines governing the disposal of hazardous waste by landfill, landfarming and deep well disposal
- Guidelines for the incineration of hazardous waste in Alberta
- Guidelines for Hazardous Waste Treatment Plants
- Hazardous Chemical Storage Guidelines
- Guidelines respecting the establishment and operation of industrial landfills
- Proposed Hazardous Chemicals Regulation

The document received wide distribution in the Province and a number of major organizations, corporations and individuals responded to the document. The response had varied widely, ranging from complete agreement to the document contents, to complete rejection of them.

In March 1985, the Provincial Government issued Alberta Regulation 49/85 under the Hazardous Chemicals Act. This regulation would control collection, treatment and disposal of hazardous waste in the Province.

In April 1985, the Hazardous Chemicals Advisory Committee became operational to advise the Minister of Environment of regulation of hazardous waste in the Province.

The initial mandate of the Advisory Committee was very clear:

- To review and make recommendations on the existing Hazardous Waste Regulation 49/85 issued in 1985.

- To review and make recommendations on the draft document (Administrative Procedures, Guidelines and Regulations for Management of Hazardous Waste in Alberta) and any update issued since the document was prepared in January 1984.

### 3.2 Approach

The Committee took the approach that each individual member represented an organization from which specific expertise could be made available, if required. In addition, the link from individual Committee Members to component organizations provided a valuable mechanism for the two-way flow of information, comments and expertise.

Committee Members determined at a very early stage that regulation of hazardous waste was a difficult and complex subject, with many facets and for which expertise was required in many areas for interpretation. Members realized the immense task of developing regulations and guidelines, and appreciated the work that had been done by the Department on the 1985 Hazardous Waste Regulation.

It was recognized at the onset that all members of the Advisory Committee could not investigate and recommend on each individual item and facet of the Guidelines and Regulation; it was also recognized that there would be an initial period required before Committee Members would be sufficiently knowledgeable to be in a position to make specific recommendations to the Minister.

### 3.3 Subcommittee Operation

In order to simplify its task, the Advisory Committee formed a number of Subcommittees to "zero in" on areas of major concern as they related to the 1985 Regulation. Subcommittees were formed to address the following topics:

- Definitions and criteria
- Testing procedures
- Transportation

Early in the activities of the Subcommittees, it was found there was significant overlap between the first two Subcommittees (definitions and criteria and testing procedures), and these were combined into a single Subcommittee that examined the 1985 Regulation in detail, clause by clause.

The transportation SubCommittee examined the implications of the Federal Transportation of Dangerous Goods Regulations as they related to regulation of hazardous waste in the Province of Alberta.

Membership on any given Subcommittee was on a voluntary basis and some committee members belonged to more than one Subcommittee. Any committee member could (and can) attend any Subcommittee meeting and could provide input at any meeting. Each Subcommittee selected its own chairman.

The Subcommittees worked enthusiastically and some of the meetings and discussions were animated, while remaining amicable. All members recognized that the differing organizations represented by the members of the Advisory Committee provided widely differing and sometimes diverse viewpoints on the same topic. It was through discussion and understanding that consensus was reached on contentious issues. It is to the credit of all members of the Advisory Committee that they reached an understanding of their colleagues' viewpoints and of the need to reach consensus through understanding and compromise.

Each Subcommittee made specific recommendations, on a clause by clause basis, if necessary, of the 1985 Regulation. The rationale for each of the recommendations was documented in detail and the proposed recommendations and rationale were brought to the full Advisory Committee for review and discussion. These specific recommendations were used as Notice of Motion items for the subsequent meeting of the full Advisory Committee, at which meeting a vote was taken.

The Advisory Committee met monthly and the interval between two meetings permitted individual members to consult with the respective organizations for comments on the proposed recommendations. This interim period between meetings permitted individual representatives to digest and review further the specific recommendations, and to consult with the component organizations in order to confirm or otherwise change the position taken by individual representatives up to that point. Each member of the Advisory Committee was well aware that he (or she) was not acting as an individual, but on behalf of an organization with specific interest in hazardous waste.

Thus, the expertise and knowledge of individual committee members was extended to the expertise and knowledge of the specific Associations and the specific member companies (if applicable) in the Associations. In total, this represented a vast network of knowledge and expertise that was available to the Advisory Committee in its deliberations and in its formulation of specific recommendations to the Minister of Environment.

Individual Associations willingly supplied this expertise to the Advisory Committee and alternates to Committee Members were provided at the Subcommittee level to ensure that the most appropriate and "the best" recommendations were made. This commitment and this enthusiasm of Committee Members showed in high attendance rates greater than 80% (at both the Subcommittee meetings and at the Advisory Committee Meetings). It represented a very significant time commitment on a voluntary basis by members of the Advisory Committee.

Most of the recommendations submitted by the Subcommittees and voted on by the Advisory Committee were adopted. This is illustrative of the discussion, understanding and consensus that took place at the Subcommittee level to reach acceptable unanimous agreement prior to referring recommendations back to the full Advisory Committee.

## 3.4 Summary of the Decision Process

In summary, the decision process adopted by the Advisory Committee was as follows:

1. Subcommittee assigned task(s) by the Advisory Committee.

2. Subcommittee selects a chairman.

3. Subcommittee discusses/reviews the items in the task, bringing in experts, as appropriate.

4. Subcommittee reaches consensus on the task items and prepares recommendations and rationale.

5. Recommendations and rationale circulated to the Advisory Committee prior to meeting.

6. Subcommittee presents recommendations to Advisory Committee with full debate.

7. Advisory Committee members review the recommendations and rationale with their component organizations before the next meeting of the Advisory Committee.

8. At its next meeting, the Advisory Committee votes on the recommendations (or possibly direct the Subcommittee investigate/review further the task items).

9. Recommendations and accompanying rationale adopted by the Advisory Committee sent to the Minister of Environment for action.

## 4.0 ADVISORY COMMITTEE SCHEDULE

The Advisory Committee decided in the early stages of its operation that a 'fast track' approach would be required in order to complete its review of the 1985 Regulation and associated guidelines by the time the Special Waste Treatment Centre was opened in mid-1987. The tentative schedule was set as follows:

| | |
|---|---|
| April 1985 | Advisory Committee initiated |
| December 1985 | Recommendations on 1985 Regulation submitted to Minister |
| Mid-1986 | Recommendations on User Guide |
| December 1986 | Recommendations on landfill, storage, test methods, deepwell disposal |
| Mid-1987 | Work on Regulation and guidelines completed |

## 5.0 ACCOMPLISHMENTS OF THE ADVISORY COMMITTEE

The Advisory Committee completed its detailed review of the 1985 Regulation and more than forty specific recommendations on the Regulation were submitted to the Minister of Environment by the end of 1985.

Both general recommendations on hazardous wastes and recommendations specific to the regulation were submitted to the Minister of Environment, and detailed rationale was appended to each Recommendation.

Prior to the end of 1985, the Advisory Committee regrouped its Subcommittees in order to provide a more effective approach in dealing with the existing guidelines on hazardous waste. This was the second part of the initial mandate of the Advisory Committee in advising the Minister of Environment on hazardous waste.

The full Advisory Committee examined the key issues and concerns relating to existing and proposed guidelines, and set up three Subcommittees with specific priority areas:

- Policy Subcommittee:
    - Overlapping jurisdictions
    - Definitions and criteria
    - Appropriateness of disposal technology
    - Decision trees

- Technical Subcommittee:
    - Land farming
    - Landfilling
    - Deep well disposal
    - Testing procedures
    - Storage, containers, incineration

- Legal Subcommittee:
  - Appeals
  - Insurance, bonding, transportation
  - Enforcement

The recommendations/voting protocol used in handling recommendations on the 1985 Regulation was used in dealing with the guidelines. During 1986, specific recommendations were submitted to the Minister of Environment on the following topics:

- Definitions and criteria
- Decision trees

- Appropriateness of disposal technology
- Land farming
- Landfilling
- Deep well disposal

- Testing procedures

## 6.0 WASTE MANAGEMENT IMPLEMENTATION PROGRAM

### 6.1 Role of the Advisory Committee

Early in 1987, a temporary change in the mode of operation of the Advisory Committee was initiated in order to bring to successful conclusion the various elements of the Waste Management Implementation Program. Until this time, the Advisory Committee members had collectively made recommendations to the Minister. Members were invited to participate in a number of new Working Groups.

The voting protocol of the Advisory Committee was modified in that each Committee representative on a given Working Group provided input and was contributory to the consensus recommendations developed by the Working Groups. The Department of Environment was represented on all the Working Groups.

The links between the Advisory Committee members and their component organizations were used effectively in providing input to the new Working Groups.

### 6.2 Approach

A Task Force was set up to oversee and coordinate the implementation of the Waste Management Program and to ensure that the majority of the regulations and guidelines were in place by the time the Alberta Special Waste Treatment Centre opened in the Fall of 1987.

The major stakeholders involved in the Implementation Program were represented on the Task Force:

| | |
|---|---|
| Alberta Environment | Deputy Minister<br>Assistant Deputy Minister |
| Alberta Special Waste Management Corporation | President<br>Vice-President, Operations |

| | |
|---|---|
| Alberta Public Safety Services | Managing Director<br>Executive Director |
| Alberta Community and Occupational Health | Managing Director<br>Workers' Health, Safety and Compensation |
| Advisory Committee | Chairman<br>Member |

The Task Force was chaired by the Technical Coordinator/Facilitator of the Advisory Committee.

The function of the Task Force was to ensure necessary elements of the Waste Management Implementation Program were "on track" and were developed/finalized in a coordinated and efficient manner.

The following Working Groups were formed:

Education/Awareness Program Working Group
Regulations Working Group
Landfills Working Group
Test Methods Working Group
User Guideline Document Working Group

The Working Groups consisted of representatives of major stakeholders, who examined in detail the various facets of hazardous waste management. Recommendations were developed by consensus within the Working Groups and forwarded to the Task Force for ratification.

The representation on the Working Groups (including representation from the organizations represented on the Advisory Committee) and their mandates are given below:

### (a) Education/Awareness Working Group

The Working Group comprised representation from the following organizations:

Alberta Environment
Alberta Public Safety Services
Alberta Special Waste Management Corporation

The mandate of the Working Group was to develop and implement an education/awareness program to facilitate the implementation of the Hazardous Waste Management Program. The mandate of the Working Group excluded development of policy on enforcement.

### (b) Regulations Working Group

The Working Group comprised representation from the following organizations:

Alberta Chamber of Resources
Alberta Environment
Alberta Public Safety Services
Alberta Special Waste Management Corporation
Alberta Workers' Health, Safety and Compensation
CCPA/FSRIA/SIA
CPA
Electric Utilities
Environmental Law Centre
Unifarm

The mandate of the Working Group was to review in detail a new draft of the Hazardous Waste Regulation and make recommendations regarding specific changes that would make the Regulation understandable and workable. Many of the Recommendations previously adopted by the Advisory Committee had been incorporated into this recent draft of the Regulation.

### (c) Landfills Working Group

The following organizations were represented on the Landfills Working Group:

Alberta Association of Municipal Districts and Counties
Alberta Chamber of Resources
Alberta Environment
Alberta Public Safety Services
Alberta Special Waste Management Corporation
Alberta Urban Municipalities Association
Canadian Petroleum Association
CCPA/FSRIA/SIA
City of Calgary
City of Edmonton
Environmental Law Centre

The mandate of the Working Group was to review in detail the Draft Industrial Landfills Guideline Document in order to:

1) Comment on landfill classification.
2) Make recommendations regarding prohibition of specific materials from landfill.

### (d) User Guideline Working Group

Representation on the User Guide Working Group was essentially that of the Advisory Committee; the Advisory Committee had addressed the requirements for the User Guide in detail and had made specific recommendations regarding elements that should be included in it.

The mandate of the Working Group was to review a further draft of the User Guide and make specific recommendations regarding its content.

### (e) Test Methods Working Group

The Test Methods Working Group was set up as a result of a recommendation by the Advisory Committee that a Working Group of knowledgeable persons be set up to review various aspects of test methods relating to hazardous waste. Representation on the Working Group was from the following organizations:

Alberta Environment
Alberta Environmental Centre
Alberta Public Safety Services
Canadian Petroleum Association
CCPA/FSRIA/SIA
Chem-Security Ltd.
Unifarm

The mandate of the Working Group was to review available testing methods and applicability to the testing of hazardous wastes, and to assess present laboratory capability in Alberta. Some consideration would be given to leachate test methods.

## 6.3 Results of Working Groups Activities

The Education/Awareness Working Group has completed its tasks. A slide/tape presentation has been developed for a general audience to explain the Waste Management Program and the operation of the Alberta Special Wastes Treatment Centre. Different types of promotional materials were also developed, in addition to a framework for training and educational programs in hazardous waste management.

The Regulations Working Group addressed reporting requirements for spills of hazardous waste and the testing and handling of residue or contaminated soil, water or other debris. A definition of Storage, including storage times and volumes was developed that was acceptable to all members of the Working Group, and this was based on the original Advisory Committee recommendation.

The Landfill Working Group reviewed in detail the Industrial Landfill Guideline Document, and made specific recommended changes in order to finalize the document. Recommendations were made on landfill design criteria, and materials to be prohibited from landfill was addressed.

The Test Methods Working Group reviewed the test methods appended to the 1985 Regulation and compared various leachate methods available to determine if a specific waste was deemed hazardous. Recommendations for a Quality Assurance/Quality Control Program were also made.

The User Guideline Working Group reviewed a draft User Guideline Document and concluded that it would be a useful document in its present form, considering that many outstanding issues had been resolved satisfactorily

## 7.0 WASTE MANAGEMENT POLICY

A draft Waste Management Policy was developed by Alberta Environment and reviewed by the Waste Management Implementation Task Force. It was further reviewed by the Advisory Committee, and the Committee's recommendations were incorporated in the final form of the Waste Management Policy issued for public review in July, 1987.

## 8.0 CONCLUSIONS

A number of important conclusions can be drawn from the activities of the Advisory Committee over the last two and one half years:

1) The consultative process for making specific recommendations on Hazardous Waste Guidelines and Regulations is effective.

2) The dialogue and discussion between representatives of major organizations with differing viewpoints and frames of reference on hazardous waste has resulted in better understanding and consensus resulting in the development of specific recommendations on existing hazardous waste regulation.

3) The recommendations made by the Advisory Committee on the existing Hazardous Waste Regulation in being acceptable to the Advisory Committee, is acceptable to many differing operations or organizations affected by the Regulation.

4) Development of detailed Recommendations and accompanying detailed rationale would not have been possible without the dedication and commitment of individual Advisory Committee members and their associations, and the resources made available through the co-operation of Alberta Environment.

5) The operation of the Advisory Committee has resulted in members of the Committee obtaining a better understanding of the many facets of hazardous waste regulation, with the implication that this understanding can be communicated to the organizations represented on the Committee.

6) This procedure for involving various diverse and affected parties may have a wider application in developing regulations, guidelines and standards.

## TABLE 1

## ADVISORY COMMITTEE MEMBERSHIP

Alberta Association of Municipal Districts and Counties
Alberta Chamber of Resources
Alberta Fish and Game Association
Alberta Public Safety Services
Alberta Special Waste Management Corporation
Alberta Trucking Association
Alberta Urban Municipalities Association
Alberta Workers' Health Safety and Compensation
Canadian Chemical Producers Association
Canadian Manufacturers Association
Canadian Petroleum Association
Environmental Council of Alberta
Environmental Law Centre
Electrical Utilities Planning Council
Fort Saskatchewan Regional Industrial Association
Strathcona Industrial Association
Unifarm

# WASTE CLASSIFICATION UNDER THE TRANSPORTATION OF DANGEROUS GOODS REGULATIONS

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## SUMMARY

Regulations under the Transportation of Dangerous Goods (TDG) Act came into effect on July 1, 1985. The TDG Regulations include procedures for determining if a waste is hazardous. All shipments of dangerous goods and hazardous wastes must be classified according to Part III of the TDG Regulations before they are transported. This paper will review the process for classifying hazardous wastes under the TDG Regulations and will outline how proposed regulatory amendments will affect the classification of some hazardous wastes.

## BACKGROUND

The Transportation of Dangerous Goods (TDG) Act was passed in 1980. The Act promotes public safety before, during and after the transporting of dangerous goods and hazardous wastes. The Act is administered by Transport Canada. Environment Canada provides technical advice and recommends regulatory initiatives on matters related to hazardous wastes.

The TDG Regulations were promulgated in July, 1985, and described classification of hazardous wastes, documentation requirements (the waste manifest) safety marks (labels, placards and signs) packing group requirements and emergency response procedures.

Other than the waste manifest, these controls apply to the transport of dangerous goods and hazardous wastes. All consignments of hazardous wastes must be accompanied by a waste manifest when they are transported. Safety marks on a container or vehicle indicate what hazards exist with the contents of the vehicle and how the contents should be handled. The packing group is the level of hazard which is inherent to a particular hazardous waste. The TDG Regulations specify what constitutes an emergency situation and, in the event of a dangerous occurrence, what procedures are to be followed.

## CLASSIFICATION OF HAZARDOUS WASTES

The classification criteria for identifying dangerous goods and hazardous wastes are described in the Regulations in Part III - Classification. All shipments of dangerous goods and hazardous waste must be classified according to Part III before they are transported. The classification system in the Regulations has been modified to accommodate wastes, especially those wastes generated by industrial processes. The responsibility to classify a hazardous waste rests primarily with the consignor or generator of the waste.

The TDG Regulations define a waste as "a product or substance intended for disposal". The Regulations control the following hazardous wastes:

- all discarded specified dangerous goods which are listed in Schedule II, List II* of the TDG Regulations;
- all industrial waste streams listed in Schedule II, List II; and
- all not fully specified waste mixtures or solutions listed in Schedule II, List II which have hazardous properties described by the criteria in Part III of the TDG Regulations.

## Classes and Divisions

Hazardous wastes are divided into classes and divisions based on the hazardous criteria described in Part III of the TDG Regulations.

There are nine different hazard classes. Each type of hazardous waste will have one of these classes as its primary classification. In addition, any given hazardous waste may have one or more subsidiary classifications.

A primary classification describes the main hazardous properties of a particular hazardous waste. The subsidiary classification describes other hazardous properties of a particular hazardous waste. These properties are considered to be of secondary concern in transportation when compared with the main hazardous properties of the waste.

In Schedule II, List II, of the TDG Regulations, the classification column, Column III, has the primary classification listed at the top and subsidiary classification(s) listed immediately below for each listed item.

The divisions are a further separation of a class to indicate more specifically the hazard of a good or waste.

The classes are numbered from one to nine (Table 1). Divisions are indicated by numbers as well, and follow a decimal point placed after the class number. In the example "1.4", 1 is the class and 4 is the division. In the example "5.1", 5 is the class and 1 is the division. For a complete description of each of the classes and divisions, refer to Part III of the TDG Regulations.

TABLE 1 DANGEROUS GOODS CLASSES

Class 1: Explosives
Class 2: Gases
Class 3: Flammable liquids
Class 4: Flammable solids, spontaneously combustible, dangerous when wet
Class 5: Oxidizers and organic peroxides
Class 6: Poisonous and infectious substances
Class 7: Radioactives
Class 8: Corrosives
Class 9: Miscellaneous dangerous substances

Class 1 - Explosives. Explosives are substances that are either capable of producing gas at a temperature, pressure or speed that they cause damage, or are manufactured for the purpose of causing an explosive or pyrotechnic effect. Explosives are found in Schedule II List I of the Regulations. They are classified by Energy, Mines and Resources Canada and cannot be a waste by definition of the Explosives Act. As such, explosives are always handled as a dangerous good.

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*Schedule II, List II, of the TDG Regulations is a list of specific and generic groups of dangerous goods and hazardous wastes.

Class 2 - Gases. Four divisions of gases are included in Class 2. Division 1 includes ignitable or flammable gases; Class 2.3 includes a poisonous gas; Class 2.4 indicates a corrosive gas, and Class 2.2 is the class and division for non-flammable, non-toxic and non-corrosive gases. An example of a Class 2.2 compound is compressed helium.

Class 3 - Flammable Liquids. Flammable liquids are sub-divided on the basis of their flashpoint. Extremely flammable liquids with a closed-cup flash point of less than -18°C are placed in Class 3.1.

Very flammable liquids with a closed-cup flash point between - 18°C and 23°C are placed in Class 3.2.

Class 3.3 is liquid with a closed-cup flash point between 23°C and 37.8°C. For international air transport, the flash point is not less than 23°C, but less than 60.5°C. For international marine transport and for wastes the flash point is not less than 23°C, but less than 61°C.

Class 4 - Flammable Solids, Substances Liable to Spontaneous Combustion, and Substances that on Contact with Water Emit Flammable Gases. A Class 4.1 substance is a solid which under normal circumstances is readily ignitable and burns persistently, or which causes or contributes to fire through friction or from heat retained from manufacturing or processing. Molten sulphur is a Class 4.1 substance.

A substance liable to spontaneous combustion under normal conditions of transport, or when in contact with air liable to spontaneous heating to the point where it ignites, such as white or yellow phosphorous, are Class 4.2 substances.

A substance which, on contact with water, emits dangerous quantities of flammable gases or becomes spontaneously combustible on contact with water or water vapour are classified as Class 4.3.

Class 5 - Oxidizing Substances and Organic Peroxides. Substances which oxidize or organic compounds that contain the bivalent "-O-O-" structure are included in Class 5.

Class 6 - Poisonous (Toxic) and Infectious Substances. A Class 6.1 substance is a solid or a liquid that is poisonous or toxic by ingestion, by skin contact, or through air inhalation of its vapours. The $LC_{50}$ and $LD_{50}$ levels are specified in the TDG Regulations.

The TDG Regulations describe organisms believed to be infectious to humans or animals and lists several in Schedule VII of the Regulations. Infectious substances are in Division 2 of Class 6.

Class 7 - Radioactive Materials. Radioactive materials with activity greater than 74 kBQ/kQ. Radioactive materials are classified by the Atomic Energy Control Board and cannot be a waste by definition of the Atomic Energy Control Act.

Class 8 - Corrosive Substances. Substances that cause visible necrosis of the skin or that corrode steel or non-clad aluminum are placed in Class 8. Test methods are specified in the Regulations. Class 8 has no divisions.

Class 9 - Miscellaneous Dangerous Goods. Substances in Division 1 of Class 9 are substances which present sufficient danger to warrant regulation, but which cannot be assigned to any other class. For example, inflatable life rafts can be hazardous in certain transport situations and are given a classification of 9.1.

A Class 9.2 indicates an environmentally hazardous substance. Class 9.3 substances are dangerous wastes which presents sufficient dangers to warrant regulation, but which cannot be assigned to any other class.

9.2 and 9.3 classifications are recommended to Transport Canada by Environment Canada and Provincial Environment Ministries. These agencies use a list of criteria in addition to those for classes 1 to 8. The additional criteria enable them to determine all of the characteristics of a substance or waste which may be hazardous to human health or the environment. The additional criteria include:

- chronic toxicity;
- aquatic toxicity;
- bioaccumulation; and
- persistence in the environment.

Substances or wastes that satisfy only these criteria above are assigned to Class 9.2 and 9.3.

These substances or wastes are added to Schedule II, List II, as:

- industrial waste streams;
- environmentally hazardous substances, (Class 9.2); or
- dangerous wastes, (Class 9.3).

I will now describe the classification procedures for wastes in four situations using the class descriptions reviewed. The four situations are:

1) classifying specified hazardous wastes;
2) classifying not fully specified hazardous wastes;
3) classifying mixtures; and
4) classifying dilute hazardous wastes.

## Classifying Specified Hazardous Wastes

This section describes how to classify specified hazardous wastes and industrial waste streams in Classes 2 to 6.1, 8 and 9.

Specified hazardous wastes are listed alphabetically in lower case letters by their specific name in Schedule II, List II of the TDG Regulations. The consignor must insert the word "Waste" immediately preceding the shipping name to indicate that it is a hazardous waste.

Industrial waste streams are wastes which come from specific industrial processes. Waste stream descriptions are listed in Schedule II, List II of the TDG Regulations. They use Waste Type 1 to 98 as their shipping names, because of the length of the actual description to identify an industrial waste stream. For example, the description used to identify Waste Type 10 is, "spent stripping and cleaning bath solutions from electroplating operations where cyanides are used in the process (except for precious metals electroplating spent stripping and cleaning bath solutions)".

There are nine steps in classifying a specified hazardous waste.

Step 1. Read Part I of the TDG Regulations to identify all relevant definitions.

Step 2. Read Part II of the TDG Regulations to determine if your product or substance is exempted from any part of the Regulations.

Step 3. Read the legend to Schedule II to determine how to use the Schedule and what the abbreviations mean. Read the first page of List I and List II for a description of the column headings.

Step 4. Consult Schedule II, List II, Column I, of the TDG Regulations to determine the specified shipping name which exactly describes your product or substance. Remember to place the word "Waste" in front of it.

Step 5. Identify the product identification number (PIN) in Column II. Note instruction #2 in the legend to Schedule II.

Step 6. Identify the classification in Column III.

Step 7. Identify the packing group in Column VII.

Step 8. Read the special provisions in Column IV for specific transportation requirements.

Step 9. Read the quantity restrictions or prohibitions in Column VIII for passenger aircrafts and vehicles. Column IX states the quantity restrictions for cargo aircrafts.

Slight variations exist in the classification procedure depending on whether the shipment is a domestic or transborder consignment (i.e. within North America) or an international consignment. Occasionally an alternate shipping name or product identification number (PIN) is required for international shipments. As well, be sure to check Column V of the list for the IMO (marine) classification and Column VI for the ICAO (air) classification.

## Classifying Not Fully Specified Hazardous Wastes

This section describes 10 steps for classifying Not Fully Specified waste substances or products. Not Fully Specified waste shipping names are used to describe general classes of waste mixtures or solutions. They are not listed by specific chemical names. They are listed in uppercase letters in Schedule II, List II of the TDG Regulations. In some cases, the letters "N.O.S." (not otherwise specified) follow the shipping name and is part of the legal shipping name. The 10 steps are listed below.

Step 1. Read Part I of the TDG Regulations to identify all relevant definitions.

Step 2. Read Part II of the TDG Regulations to determine if the product or substance is exempted from any part of the Regulations.

Step 3. Do "flash point test" or other tests, data collection and calculations as appropriate. This is done to determine the hazardous properties of the product or substance.

Step 4. Check all criteria for Classes 3, 6.1 and 8 and the definitions of Classes 2, 4, and 5 found in Part III of the TDG Regulations. Determine the primary classification, subsidiary classification (if applicable), and packing group for the product or substance according to the applicable definitions, criteria, tests or calculations from Part III.

Step 5. If you identify more than one classification during the analysis of the waste, refer to the Order of Precedence Table (Schedule I of the Regulations) to determine which classification is primary and which is subsidiary.

Step 6. If you identify more than one packing group during the analysis of the waste, select the packing group with the lowest roman numeral.

Step 7. Read the legend to Schedule II to determine how to use the Schedule and what the abbreviations mean. Read the first page of List I and List II for a description of the column headings.

Step 8. Choose the Not Fully Specified shipping name from Schedule II, List II, that best describes the primary and subsidiary classifications. Remember to place the word "Waste" in front of it.

Step 9. If the shipping name has the letters "N.O.S." with an asterisk (*) beside it, place the chemical names of the substances in the mixture, in parentheses, following the "N.O.S." shipping name. Only identify the substances that cause the mixture to have the primary and subsidiary classes of the "N.O.S." shipping name.

Step 10. Read the special provisions in Column IV and the quantity restrictions and prohibitions for passenger aircraft and vehicle transport and cargo aircraft in Columns VII and IX.

## Classifying Mixtures

When a specified hazardous waste is mixed with a non-hazardous waste, place the word "mixture" or "solution", whichever is more appropriate, following the TDG Regulations shipping name. When classifying a mixture of two or more hazardous wastes, follow steps one to 10 in the previous section on classifying Not Fully Specified hazardous wastes.

## Classifying Dilute Hazardous Wastes

The following three situations may occur for a hazardous waste that is dilute and does not meet the classification criteria.

1. The TDG Regulations will not apply when a waste:
   - has no subsidiary classification; and
   - does not meet the criteria of the primary classification described in Part III.

2. The subsidiary classification may still apply for a hazardous waste that:
   - has a specified shipping name;
   - has a subsidiary classification, other than 9.2; and
   - does not meet the criteria of the primary classification described in Part III.
3. The subsidiary classification will still apply for a hazardous waste that:
   - is in a domestic or transborder consignment;
   - has a specified shipping name;
   - has a subsidiary classification of 9.2; and
   - does not meet the criteria of the primary classification described in Part III.

In this case, add the words "waste contaminated with" immediately preceding the shipping name, and remove the product identification number.

## AMENDMENTS TO THE REGULATIONS RESPECTING HAZARDOUS WASTE CLASSIFICATION

Environment Canada and the Canadian Council of Resource and Environment Ministers (CCREM) Waste Committee have recommended to Transport Canada a series of amendments to the Regulations respecting hazardous wastes. Transport Canada has published the draft amendments in their "Dangerous Goods Special Bulletin" in advance of legal review as a proposed regulation. This advance consultation is intended to provide a wide opportunity for comment during the regulations development.

The draft amendments identify several areas associated with hazardous wastes. Key points related to classification are:

- the amendments expand the current definition of hazardous wastes;
- the amendments clarify some current waste classification criteria;
- the amendments introduce new classification criteria for wastes that leach hazardous constituents.

### Definition of Waste

The definition of "Waste" will be expanded to include all hazardous wastes operations, and at the same time will be clarified to exclude all goods which are defective, off-specification or surplus and are returned directly to the manufacturer or supplier. The definition will now include wastes going to treatment and recycling operations.

Recyclable material will be defined to include material headed for reuse, recovery or recycling. The amendments also introduce a mechanism to reduce any regulatory burden for recyclable materials. Provisions are included for provinces to exempt certain recyclable material from control through provincial regulations.

Recyclable material does not include compounds applied into or onto land or compounds disposed of in thermal destruction processes. This exception is to safeguard against road oiling with contaminated oil, and inadequate incineration of hazardous wastes.

### Clarification of Classification Criteria

The amendments will clarify points related to the application of the corrosive criteria for wastes. As well, two new waste types will be added that describe additional reactive properties. Wastes that emit toxic fumes on contact with water or air, or any cyanide or sulphide bearing wastes will be controlled as a waste type.

### New Classification Criteria

Wastes that produce a leachate containing listed contaminants above a regulated concentration will now be controlled as a Class 9.3 hazardous waste. The shipping name of the waste will be "leachable toxic waste". There is a prescribed test to determine the leachate characteristic, but those of you who are familiar with the EPA EP Toxicity Characteristic or Ontario's Regulation 309 leaching procedure will recognize this procedure as it is very similar.

## TRANSBOUNDARY SHIPMENTS OF HAZARDOUS WASTES

I would like to finish my discussion today with a brief mention of transboundary shipments of hazardous wastes. Last year at the Waste Management Conference we said that the Canada/U.S. Memorandum of Understanding Regulating the Export and Import of Hazardous Wastes for Disposal would be signed in the fall. The Agreement was signed October 28, 1986 and became effective November 7, 1986. A six-month review of the Agreement occurred in May of this year. Other than minor operational problems, the system is running smoothly. Copies of the Agreement are available from Environment Canada. In 1988, the Users' Guide to the Hazardous Wastes Manifest will be modified to include Agreement requirements for transboundary shipments.

# HAZARDOUS WASTE LISTING/DELISTING IN ONTARIO

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## INTRODUCTION

*In order to ensure proper handling and disposal of wastes, Regulation 309 under the Environmental Protection Act of the Ontario Ministry of the Environment (MOE), provides definitions of hazardous wastes; and details the requirements for generators, carriers/receivers, and waste manifesting. The classification of hazardous wastes is achieved by a listing/testing approach, whereby wastes are deemed hazardous by definition, and listed in Schedules, or by characteristics (e.g. corrosivity), determined mostly through test protocols.*

*The Regulation further provides for a mechanism of listing/delisting of specific wastes as a method of continually updating of the Schedules. This assumes that new wastes that can be shown to be hazardous are added to lists; and listed wastes, at a particular facility, judged to be non-hazardous can be delisted.*

*This process is in its final stages of development and a few applications are being processed through the system.*

## DEFINITIONS OF HAZARDOUS WASTES

*The criteria adopted by the MOE for definition of hazardous wastes are consistent with those under the U.S. Resource Conservation and Recovery Act (RCRA), and the Canadian Transportation of Dangerous Goods Act (TDGA).*

*Specific tests or evaluations, which show results in a defined range, can be done to identify one of the following hazardous characteristics, which are defined in detail in Regulation 309 and in the Registration Guideline Manual (MOE, 1985):*

- *Pathological*
- *PCB wastes*
- *Ignitable*
- *Corrosive*
- *Reactive*
- *Leachate Toxic*

*In addition, chemical lists, derived from Appendix VIII of the Resource Conservation and Recovery Act (RCRA), of the USEPA, are utilized for information on hazardousness, due to toxic, carcinogenic, mutagenic or teratogenic effects. These are titled Hazardous Industrial Wastes, Acute Hazardous Waste Chemicals, Hazardous Waste Chemicals, and Severely Toxic Contaminants.*

*Generally, all generators of waste in Ontario must classify their wastes and register those that are liquid or hazardous. If the waste or the constituents of the waste are not listed in Schedules 1, 2 or 3 (described later), each hazardous characteristic must be evaluated and/or tested. If the test or the evaluation is indicative of one of the characteristics, the waste is classified as hazardous waste.*

## SCHEDULES OF REGULATION 309

*Regulation 309 includes three schedules where some hazardous wastes have been tested and explicitly identified either as specific waste streams or as specific chemicals. The majority of the delisting petitions are likely to be for wastes from Schedule 1, which is virtually identical to the* waste listings under the Schedule II, List II of the Canadian Transportation of Dangerous Goods Regulations.

### Schedule 1

Hazardous industrial wastes have been listed in Schedule 1 for non-specific sources as well as for specific industrial sources. Wastes from non-specific sources include a large variety of solvents and sludges from recovery of the same solvents, waste water treatment sludges from electroplating operations, and metal finishing solutions containing cyanides. The wastes have been listed mostly because of their toxicity or in some cases because of their reactivity and ignitability.

Most of the wastes from specific sources have been listed because of the toxicity of the constituents. In a few cases, the criterion for listing was either corrosivity (e.g. spent pickle liquor from steel finishing operations) or reactivity. The specific sources listed in Schedule 1 include industrial sectors such as organic/inorganic chemicals production, pesticides and explosives manufacturing, petroleum refining, and primary metal industries.

### Schedule 2

In the listing of Schedule 2 wastes, individual constituents have been identified either as acute or other hazardous waste chemicals. The classification of acute wastes is determined from the high level of toxicity of individual constituents when compared with the toxicity criteria. It is important to note that these constituents listed in Schedule 2 refer only to discarded commercial chemical products, manufacturing intermediates or off-specification products. This definition also includes materials such as pharmaceutical or pesticide waste products that contain active ingredients of Schedule 2. Active ingredients are chemical constituents that have been included in a formulated product for an intended effect. It should be noted that a contaminant of Schedule 2, if present in a waste stream (as opposed to a waste by-product), does not make that stream hazardous. Hazardous contaminants in waste streams are normally listed in Schedule 1, Schedule 3 or are classified as hazardous because of the hazardous characteristics, imparted to the waste stream.

### Schedule 3

A few chemicals, such as dioxins, have been found to have a severe level of toxicity at a low dosage. As such, wastes containing low concentration of these chemicals are classified as severely toxic wastes. They have been listed separately because of additional precautions in waste management; there is no small quantity exemption and the threshold value for listing is 1 ppm.

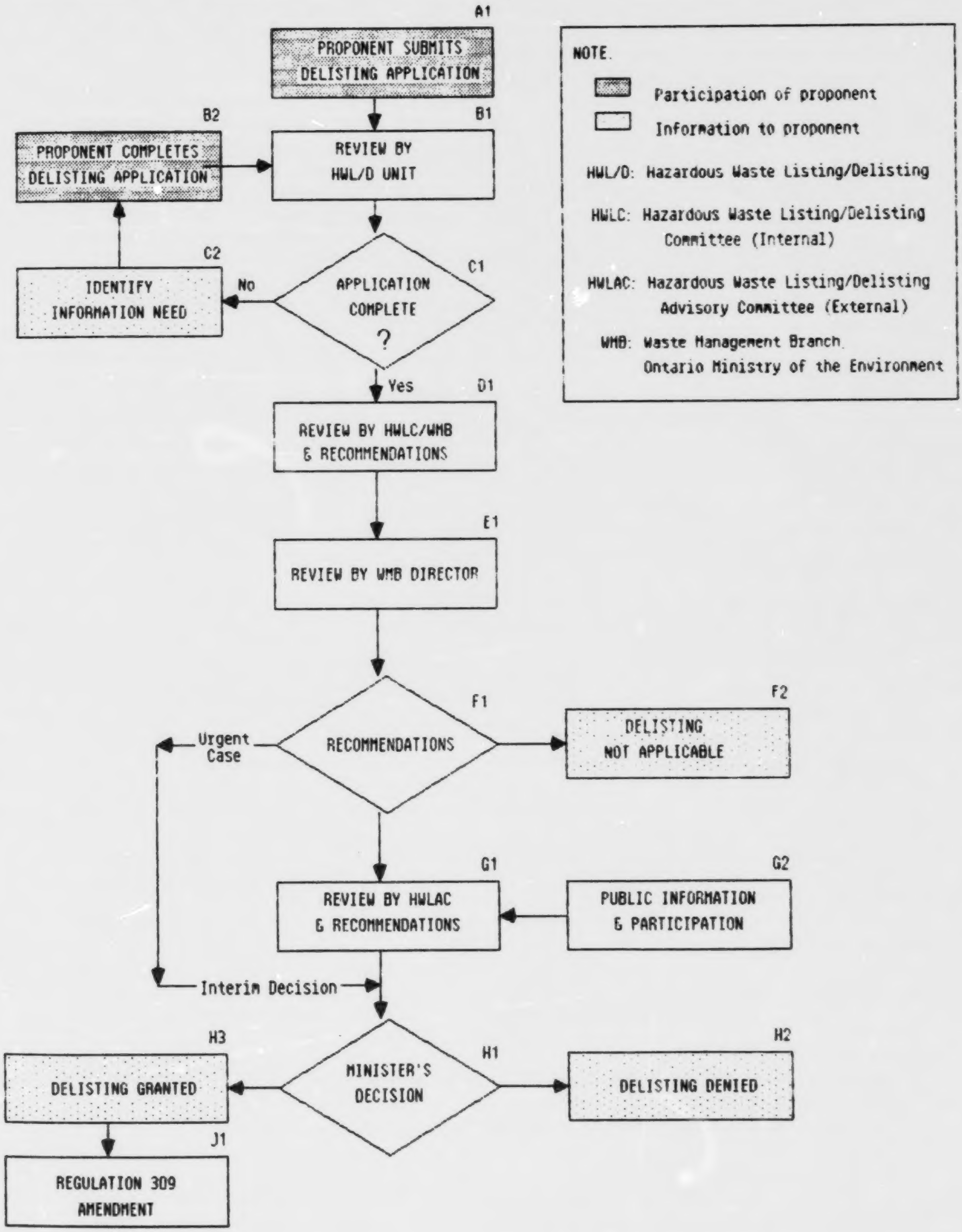
## LISTING PROCESS

The listing process involves reviewing extensive data on toxicity of selected chemicals. If the chemical is found to be toxic or hazardous under the definition criteria, the waste may be listed in the Schedules of Regulation 309. Other factors to be considered before a waste is listed include:

- impact of listing an industrial waste stream on the effective waste management practices and policies
- economic impact on the industrial sector affected.

The initial listing of hazardous wastes in the Schedules of Regulation 309 relied on the background research compiled by USEPA. Present listing efforts and initiative come from governmental organizations such as:

Figure 1: HAZARDOUS WASTE DELISTING PROCESS IN ONTARIO


A1
PROPONENT SUBMITS DELISTING APPLICATION
B2
B1
PROPONENT COMPLETES DELISTING APPLICATION
REVIEW BY HWL/D UNIT
C2
C1
IDENTIFY INFORMATION NEED
No
APPLICATION COMPLETE ?
Yes
D1
REVIEW BY HWLC/WMB & RECOMMENDATIONS
E1
REVIEW BY WMB DIRECTOR
F1
F2
Urgent Case
RECOMMENDATIONS
DELISTING NOT APPLICABLE
G1
G2
REVIEW BY HWLAC & RECOMMENDATIONS
PUBLIC INFORMATION & PARTICIPATION
Interim Decision
H3
H1
H2
DELISTING GRANTED
MINISTER'S DECISION
DELISTING DENIED
J1
REGULATION 309 AMENDMENT
NOTE.
Participation of proponent
Information to proponent
HWL/D: Hazardous Waste Listing/Delisting
HWLC: Hazardous Waste Listing/Delisting Committee (Internal)
HWLAC: Hazardous Waste Listing/Delisting Advisory Committee (External)
WMB: Waste Management Branch, Ontario Ministry of the Environment

- *the regional/field staff of MOE,*
- *Hazardous Waste Listing/Delisting Committee (HWLC) of MOE,*
- *Air Resources and Water Resources Branches, MOE,*
- *Hazardous Contaminants Co-ordination Branch, MOE*

*and from private and industrial organizations such as:*

- *waste management and treatment industries,*
- *public interest groups and associations.*

*Once a listing project has been initiated, the review procedures are similar to the delisting procedures, which are detailed later on in this paper.*

## *DELISTING PROCESS*

*The complete delisting process is illustrated in Figure 1. It involves a formal application from the generator and a comprehensive review by the Ministry of the Environment and by an external delisting committee. To better understand the procedures involved in the delisting process, we start with the examination of the rationale for delisting.*

### *Rationale for delisting*

*A specific waste, once delisted does not have to be managed as a hazardous waste, and this may have significant economic impact for the generator of the waste. In the process of delisting a hazardous waste, the proponent must demonstrate that the waste does not meet any of the criteria for which the waste was originally listed (i.e. toxicity or hazardous characteristics). In addition, absence of hazard from other constituents of concern listed in Appendix C of the Delisting Guidance Manual (MOE, 1987) (Draft only), has also to be demonstrated.*

### *Guidance manual*

*The MOE is preparing a guidance manual to assist generators in the preparation and submission of a delisting application. The manual includes an introduction where the rationale of delisting is explained. The major part of the manual refers to the requirements for descriptions of the waste generation processes, the sampling program, the sample analysis, the Quality Assurance and Quality Control (QA/QC) program, and the waste management practices. The last chapter guides the proponent through the delisting application form.*

### *Submission of the application*

*Once the proponent is familiar with the requirements of the delisting process, using information from either the delisting guidance manual or from MOE staff, a delisting application is submitted to the Hazardous Waste Listing/Delisting Unit (HWL/D) (see A1 in Figure 1) of the Waste Management Branch (WMB) of MOE.*

### *Review of the application*

*A number of persons or governmental/public organizations may be involved in the review of the application. This includes:*

- *HWL/D Unit*
- *Hazardous Waste Listing/Delisting Committee (HWLC)*
- *Waste Management Branch Director*
- *Hazardous Waste Listing/Delisting Advisory Committee (HWLAC)*
- *Public groups*
- *Minister of the Environment.*

*The HWLC is comprised of representatives of Air Resources, Water Resources, Hazardous Contaminants Co-ordination, Laboratory Services, Waste*

*Management Branches, Regional Operations at the MOE, along with the Ministry of Labour's staff to provide expertise on matters of toxicology and occupational health.*

*Preliminary review of the application (B1), may show need for additional information (B2). A document is prepared by the HWL/D Unit and presented to the HWLC. This summarizes the information received with respect to the process, laboratory analysis, waste management, etc., along with the recommendations of the Unit. HWLC evaluates the application and the document prepared by the HWL/D unit and provides its views as to whether the particular wastes should be delisted, to the Director, WMB. The Director forwards the package with his suggestions to an external advisory committee appointed by the Minister of the Environment (F1). This committee is to provide the expertise of members representing academics, waste management associations, engineering consultants, toxicologists, etc., and is called the external Hazardous Waste Listing/Delisting Advisory Committee (HWLAC).*

*In urgent cases, the Director WMB may also forward his recommendations to the Minister, requesting an immediate interim decision. The Director, in cases where he is satisfied that delisting is not required/possible, may deny the application (F2).*

*The HWLAC has the authority to ask for public comments and include them as part of its final recommendation package to the Minister (G1).*

*The Minister's decision, if delisting is approved, requires a cabinet approval for the regulatory Amendment necessary in each instance (H3/J1). The delisting may, of course, be denied (H2), if absence of hazard to health or environment is not satisfactorily demonstrated.*

## *IMPORTANT DELISTING ISSUES*

*A number of important requirements have been emphasized in the drafting of the delisting guidance manual and the delisting application form.*

### *Description of waste generating process*

*The proponent is required to submit with his application a comprehensive description of the waste generating process: e.g. description of raw materials, by-products, manufacturing lines and equipment, typical operation cycles, surface/equipment preparation, cleaning, degreasing, coating or painting processes, schematic diagram of processes, etc. This process identification serves two purposes. Firstly, it identifies the reasons why a waste, which is usually listed as hazardous when generated from similar processes, is not hazardous under the proponent's process. Secondly, it provides to the MOE staff valuable information for the assessment of the variability in the process and in the nature of the waste.*

*The proprietary nature and confidentiality of the process is respected by the MOE. However, the MOE would not consider information restriction due to the proprietary nature of process as a valid reason for incomplete process description.*

### *Representative Samples*

*One of the most important issues in the delisting of a hazardous waste is the assessment of the nature of the waste. This assessment can only be done with some degree of confidence if samples obtained for analysis are truly representative of the waste, and if they reflect a relatively accurate measure of the variation of the constituent concentration. The variation may be over time, due to batch process operation, due to normal cycles in a continuous process, or due to stochastic variations in a variable process.*

*The variation may be also over space if the waste has been accumulated in piles or collected in tanks or lagoons, before sampling and disposal.*

*In consultation with the MOE, the proponent is required to develop and document a sampling program which will consider the variations. Useful information regarding waste sampling is available from the manual, and the Industrial Waste Sampling Guideline (MOE, 1987) (Draft only).*

## *Monitoring and auditing program*

*Once the proponent has submitted a complete document, and a delisting has been granted based on the information provided, the proponent will still be responsible for proper waste disposal. Because of the remote possibility that the delisted waste may become hazardous due to process upsets, a monitoring program may be included as part of the delisting. This may include recycling or reprocessing of wastes that may show contaminants above pre-set limits. The monitoring program is detailed in the delisting confirmation and carried out by the proponent at his own expense.*

*MOE reserves the right to conduct unannounced audits at the generating site or along the disposal operation. Replicate samples may also be required as part of the audit.*

## *REFERENCES*

*MOE, 1985, Registration guidance manual for generators of liquid industrial and hazardous wastes. Ontario Ministry of the Environment, July 1985. (Copy available in English or French at Waste Management Branch, MOE).*

*MOE, 1987, Delisting guidance manual for hazardous waste (Draft only). Ontario Ministry of the Environment, July 1987.*

*MOE, 1987, Industrial waste sampling guideline (Draft only). Ontario Ministry of the Environment, June 1987.*

*USEPA, 1980. Background document. Resource Conservation and Recovery Act (RCRA). Subtitle C: Identification and listing of hazardous waste. Office of Solid Waste, U.S. Environmental Protection Agency, November 14, 1980 (numerous updates after 1980).*

# LEGISLATIVE DIRECTIONS IN HAZARDOUS WASTE MANAGEMENT

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Global concerns for greater environmental protection surfaced in the early 1970s. Initially legislation was drafted that provided general safeguards to air and water. By the end of the decade, hazardous waste issues were receiving international attention as well. The focus of these statutes was to provide general guidance to regulatory agencies about priorities.

In the decade of the 1980s, legislative mandates and international agreements are becoming more specific. Instead of the general statutory guidance typical of the 1970s, very specific requirements are emerging. Perhaps the most obvious shift from generalities to specifics is occurring in the United States; our Congress has begun to regulate through legislation. Likewise the Federal Republic of Germany has recent legislation related to waste reduction that provides very specific mandates. In addition, the Organization for Economic Cooperation and Development (OECD) is negotiating new definitions of hazardous waste that go far beyond those found in member countries, particularly here in North America.

This paper reviews some recent legislative packages. The focus for new trends is highlighted in areas of waste definition, source reduction, and management restrictions.

## NEW DEFINITIONS OF HAZARDOUS WASTES

In an attempt to provide greater control of transfrontier movement of hazardous wastes, OECD is working on a draft agreement.(1) Members of OECD have departed from more general definitions, which indicate that determinations of potential hazard are based on general evaluations of toxicity, mobility, and persistence in environmental media. The draft document being considered by OECD's Waste Management Policy Group has proposed definitions of disposal and waste that are very specific and can broaden the scope for regulation dramatically.

For example, the draft document contains six tables that must be referenced when determining the hazardous nature of wastes to be exported. Specifically the document states:

> Definitions
>
> For the purpose of control of transfrontier movements involving any OECD Member country, the

terms WASTES, DISPOSAL, and HAZARDOUS WASTES are defined below, by reference to a series of Tables:

1. WASTES are materials designated for DISPOSAL, for reasons specified in Table 1.

2. DISPOSAL means any of the operations specified in Table 2.

3. HAZARDOUS WASTES are:

   i) all wastes which belong to any of the categories described in Table 3, unless such wastes can be shown not to possess any of the characteristics listed in Table 5; and

   ii) any other wastes which exhibit any of the characteristics listed in Table 5 unless such wastes, as a result of being radioactive, are subject to control systems applying specifically to radioactive materials.

Table 3 through 5 referenced in this definition are lists of generic types of hazardous wastes, constituents of wastes which render them hazardous and characteristics of hazardous waste. Chart I illustrates the components found in each of these three tables.

A major shift found in this draft agreement is the "burden of proof for hazardousness." In the United States and in legislation developed by other countries, a waste is determined to be hazardous only when data are available that clearly show its hazard potential (i.e., "innocent until proven guilty"). The draft OECD agreement appears to identify all wastes as hazardous unless proven otherwise (i.e., "guilty until proven innocent").

## WASTE MINIMIZATION

As cost of waste management increases and capacity of treatment and disposal becomes less available, reduction of wastes generated has gained greater global attention. Policy makers are exploring legislative mechanisms that encourage, if not mandate, waste minimization activities. To date the United States and the Federal Republic of Germany have implemented some far-reaching legislation.

During 1984 the U.S. Congress initiated statutory mandates to reduce the amount of waste generated and to reuse and recycle waste constituents, to the extent possible.(2) Although voluntary reduction in the volume of hazardous wastes was occurring in individual firms, the U.S. Congress did not consider this effort to be receiving prominence throughout the country. Therefore, the 1984 legislation provides that waste minimization

# CHART I. EXAMPLES OF ITEMS IN OECD TABLES 3-5

## Table 3. Generic Types of Hazardous Wastes

| | |
|---|---|
| 1 | Anatomical substances; hospital and clinical wastes |
| 2 | Pharmaceuticals, drugs, medicines and veterinary compounds |
| 3 | Wood preservatives |
| 6 | Halogenated organic substances not employed as solvents |
| 7 | Tempering salts containing cyanides |
| 8 | Mineral oils and oily substances, (e.g., cutting sludges, etc.) |
| 12 | Inks, dyes, pigments, paints, laquers, varnish |
| 13 | Resins, latex, plasticizers, glues/adhesives |

(Total of 40 codes)

## Table 4. Constituents of Wastes Which Render Them Hazardous

| | |
|---|---|
| C1 | Beryllium; beryllium compounds |
| C2 | Vanadium compounds |
| C3 | Chromium (VI) compounds |
| C4 | Cobalt compounds |
| C19 | Inorganic sulphides |
| C20 | Inorganic fluorine compounds excluding calcium fluoride |
| C21 | Inorganic cyanides |
| C23 | Acidic solutions or acids in solid form |
| C24 | Basic solutions or bases in solid form |
| C25 | Asbestos (dust and fibres) |
| C26 | Phosphorus; phosphorus compounds, excluding mineral phoshates |
| C27 | Metal carbonyls |

(Total of 51 codes)

## Table 5. Characteristics of Hazardous Wastes

| | |
|---|---|
| H1* | Explosive |
| H2* | Oxidizing |
| H3* | Inflammable |
| H4** | Irritating |
| H5** | Harmful |
| H6** | Toxic |
| H7** | Carcinogenic |
| H8* | Corrosive |
| H9* | Infectious |

(Total of 14 codes)

programs must be initiated at all manufacturing plants, regardless of the size. Every shipment of hazardous wastes moving from a generator to treatment or disposal facilities must include a certification that a waste minimization program is in effect. The biennial reports required of all generators must include descriptions of the minimization program and data on extent of volume reduction.

The U.S. Congress further required that the Federal regulatory agency must evaluate the extent of waste minimization being implemented nationally. The mandate was to evaluate the range of state programs that exist, the barriers that may exist for more comprehensive waste minimization in medium to small manufacturing companies, and give recommendations to Congress about mechanisms that would encourage greater corporate efforts to minimize waste generation.

Many in the United States have suggested that the certification process is not sufficient. There is little enforcement authority associated with it. Thus, new legislation has been introduced that will establish a regulatory program aimed at waste reduction.

The Federal Republic of Germany also has taken new directions in the area of waste reduction. As early as 1972, the Fourth Amendment to the Waste Law required that "where technically feasible, generation of wastes should be avoided and low-waste technology adopted."(3)

In August of 1986, new legislation emerged that has some very major implications for industrial development in that country: The Waste Avoidance and Waste Management Act.(4) The focus of that legislation is to force the reduction of hazardous constituents in wastes by limiting development of products containing these constituents and by stringent requirements for recycling of such products. The legislation provides detailed descriptions about avoidance of hazardous waste generation. Mandates for recycling and reuse of products containing hazardous constituents are included. For example, if it is at all technically feasible and if the costs for reuse, as compared to other disposal routes, are not unreasonably high, the Act states that reuse and recycling will be given priority over any other disposal route.(5) The legislation does recognize, however, that a market for these materials must exist. This legislation, in addition, singles out requirements for managing waste oil.(6)

The statute further mandates development of regional waste management plans.(7) These waste management plans must consider mechanisms for waste avoidance and recycling. The legislation also requires that companies shall appoint waste management officers, whose duties are to supervise the handling of waste from the point of generation to final disposal.(8) These officers are also to work towards the development and the introduction of environmentally sound industrial processes that minimize waste production and utilizes recycled materials. There will be restrictions placed upon and licenses required for the movement of waste across regional boundaries under the authority of this Act to assure that the waste are being managed in a way appropriate with the legislative directions.

Probably the most far reaching aspect of this legislation is found in Article 14, which addresses requirements for marking, labeling, separate disposal, return of used goods to the manufacturer and an obligation of the producer to accept these returned materials. The Act states:

> "To avoid or reduce noxious substances in waste or to insure their environmentally compatible management, the Federal government is herewith authorized to provide by statutory ordinance certain products due to the content of the substance expected to arise from their intended use shall only be put into circulation if they are provided with an appropriate marking, labeling which points out in particular the necessity of return to the manufacturer, distributor, or specified third party." (underline added)

For those wastes that are considered to have particularly high concentrations of "noxious" substances, appropriate re-use and recycling activities must be developed. These wastes shall be kept, collected, transported and treated separately from all other waste and documentation will be submitted to substantiate this. The distribution of those products considered to contain noxious substances will be allowed only when all residual material can be returned to the manufacturer.

Restrictions on products will be imposed when necessary, such as distribution only in certain formulations and for specific applications that guarantee the appropriate management of any residual or waste material. The long term implication is that the Federal government will become more involved in "Board Room" decisions. Toward this end, the new Act also requires that the Federal government will specify objectives for waste reduction to be reached within a particular period of time.

Although not imposing similarly stringent legislation, other countries have begun to focus attention on waste minimization activities. For example, Denmark and Sweden are developing legislation that requires substitution of dangerous substances found in specific products. These two countries have targeted compounds such as cadmium, plasticizers and mercury as first efforts for minimization through substitution. Japan also has launched efforts to reduce mercury and cadmium use in batteries. In Australia, legislative demands require that new industrial ventures must employ "low-waste" technologies, to the extent possible.

## MANAGEMENT RESTRICTIONS

In a strong desire to end the re-circulation of hazardous compounds throughout the environment, the U.S. Congress recently mandated an end to a dependance on land disposal for management of hazardous wastes. The concept of banning the use of various land disposal options first emerged in state legislative initiatives. However, actual full implementation of such statewide bans rarely has occurred.

In an effort to insure that land disposal no longer would be the preferred choice in managing hazardous wastes, the U.S. Congress enacted very strong treatment mandates and deadlines for imposition of those mandates. First, the Congress stated that all hazardous wastes must be treated. Second, specific dates were included in the statute for restricting land disposal options. This took the form of bans. For example, Congress identified types of hazardous wastes and mandated that treatment standards be developed by a certain date. If the regulatory agency does not promulgate the standards by the specified date, the wastes would be prohibited from land disposal. Once the standard has been promulgated, only residues from the prescribed treatment could be placed in the land. The final deadline is 1990 -- at that time mechanisms must be in place for treating all hazardous wastes.

This mandate for destruction of hazardous constituents also was included in the Superfund Amendments and Reauthorization Act (SARA) of 1986.(9) There was a perception that the regulatory agencies were simply playing musical chairs in managing Superfund wastes. Therefore, the U.S. Congress mandated that in evaluating management options for these wastes, permanent solutions were to take precedence over on- or off-site containment.

A similar trend is slowly occurring internationally; however as recently as 1985, some European countries were still disposing of industrial and hazardous waste into the ocean. Recycling has been practiced wherever possible, but again it is not always considered the most predominant mechanism for disposal. In Western Europe, although the majority of the waste is still landfilled, there is increasing movement toward incineration and physical/chemical treatment.

This trend exists in the Eastern European countries also, where 90% of all hazardous waste has been placed into land disposal. Japan pretreats nearly 68% of hazardous wastes prior to land disposal. Although Hong Kong still uses ocean dilution and dispersal principles as a major management option, there is emerging concern for the need to have specialized treatment and disposal facilities. The United Kingdom also is attempting to reduce dependence on land disposal. Some wastes are prohibited from specific landfills. In addition, incineration and treatment is encouraged, but not yet legislatively mandated.

No one would argue with the desirability of some management restrictions. However, the implementation of these is proving to be very difficult. Two problems prevail. One is the scientific complexity of identifying appropriate treatment standards for the diverse range of hazardous wastes identified within regulatory programs. In the United States, the regulatory agency has chosen to develop performance standards based on "best demonstrated available technology." This is an approach that has the support of the regulated industries. By using performance standards, it will be possible to improve, continually, available management technology. However, because of the way hazardous wastes are identified and listed within the U.S. program, selecting the appropriate performance standard will be difficult and time-consuming. The task would be even more difficult if the OECD proposal mentioned previously, for definition and disposal, were to be adopted by international agreement.

Second, there is much concern that capacity will be extremely limited for properly managing wastes on a regional and global basis. As the directions in choice of management options change (e.g., from land-based and ocean disposal), there is a substantial concern that unless long-range planning occurs, there will be very limited capacity for dealing with these wastes. In some countries the current, short-term answer is an increase in exports to those areas that do have facilities not operating at top capacity (e.g., to the United Kingdom and Eastern European countries). This was made apparent upon a recent visit in the United Kingdom where much of the waste treated at a stabilization processing facility was imported from other European countries.

## LONG-TERM IMPLICATIONS

Two trends are emerging on a global scale. One is an apparent broader application of the definition of hazardous wastes. The OECD draft agreement presumes most wastes are hazardous requiring proof that specific wastes are not. Although most current definitions are more restricted than that proposed by OECD, Federal governments and general public seem to want broader applications of a similar definition.

A second trend is to move into corporate decisions via legislative mandates. Germany's Waste Management Act is perhaps the most glaring example. However, the new directions in the United States with management restrictions and waste minimization efforts could begin to restrict product development.

While to date legislative trends of this nature have focussed strictly on hazardous waste activities, there could soon be a "spill-over" into the solid (i.e., nonhazardous) waste area. One of the trends that we see occurring in the United States is the meshing of requirements of hazardous and solid waste activities. The regulatory programs are becoming more similar every day. For example, the regulations for our sanitary landfills are modeled closely after the hazardous waste requirements. In addition, currently in the United States, there is a major legislative effort to impose very stringent regulatory requirements on waste-to-energy plants that in some way do mimic what we see for hazardous waste incineration.

The new push within the OECD to re-define hazardous waste might accelerate the merging of solid and hazardous waste regulatory activities on a more global scale. In addition, some "avant-garde" European countries recently have considered requirements for environmental impact assessments for all waste facilities --solid and hazardous.

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# HOUSEHOLD HAZARDOUS WASTES

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## Background

For some time there has been a concern in Manitoba about the disposal of household hazardous wastes. These are the waste products that can be found in our kitchens, bathrooms, yards, basements and garages - formerly useful products but because of their characteristics such as ignitability, corrosivity, reactivity or toxicity, they present a problem when the time comes to throw them or their containers away.

Although wastes such as paint thinners, cleansers, pesticides, bleaches, furniture polishes etc. are provided in homes in small quantities the total from a community or city when disposed of at a municipal landfill may be a significant source of groundwater pollution. A number of communities in Canada and the USA have specified a certain time when households can bring such wastes to a designated location where they can be sorted, packaged and safely transported to a commercial facility for disposal.

It was felt that few people consider the hazard presented by many household chemicals when disposed of through the municipal waste management system. A program for the safe disposal of household hazardous waste would protect the environment, remove a safety threat in the home and also enhance sanitation workers' safety.

## Site Selection

Once the decision to proceed with H.H.W. days had been made, the first hurdle faced was to select a site. The following were considered desirable when screening possible sites:

- a fairly central location in Winnipeg preferably relatively well known to city residents.

- an area with good access and egress for vehicles and with sufficient space to segregate and store wastes and allow for parking of a number of vehicles.
- availability of water and sewage and desirable to have lab facilities with fume hood and mixing basin.
- facilities close by for project staff such as lunchroom/coffee shop, washrooms, change facilities, reference books.

The site selected was the parking lot adjacent to the office building of Provincial Environmental Management. This site had some obvious advantages:

- the site known as FOC "Fort Osborne Complex" is centrally located in Winnipeg and the location is well known to Winnipeg residents.
- the entrance to the site is through a "gate" which provides a simple way of signing to show hours of operation and when the site is open or closed.
- the "circular" road around the site, designated for one way traffic provides ready-made routing to and from the working area.
- the site has water and sewage access readily available.
- a large paved parking area provides ample space for the project (approx. 150' x 225')
- 2 3 yd garbage containers provide ready disposal for packaging, containers and other landfillable wastes and are serviced on an as-required basis.
- Bldg. 2 has lab facilities including a dilution sink and a fume hood, washrooms, a cafeteria, and a technical library are also for staff. As the bldg. houses Waste Management staff there is the

added flexibility of moving staff to and from the work area as required.

- if the weather is cold or wet Bldg. 2 is also useful for staff to warm-up or change clothes.

### Staff and Equipment

It was decided that a staff of approximately 15 would be required to operate the H.H.W. project. This was composed of 4 chemists, 2 engineers and 9 other staff including summer students. Staff were recruited from the City of Winnipeg, the Provincial Environment Dept. and Environment Canada. Safety equipment and clothing such as neoprene gloves, rubber boots, lab coats, aprons, face shields, eye wash bottles and first aid kits were available for staff.

A hose was nearby to provide a "deluge shower" if necessary. Several fire extinguishers were also available if required. Three walkie-talkie units were used, mainly to provide communication between the entry point to the site and the receiving area but they also could have been used in an emergency situation.

A 2 hour training session was held for all participants 2 days before the project to review all procedures with particular emphasis on safety aspects.

### Publicity

Early in the planning process for H.H.W. days it was decided that success of the project would depend heavily on the amount of publicity that could be generated to ensure households were aware of the service and of the type of wastes that could be accepted. Twenty thousand flyers were printed for wide distribution. These were provided to schools, universities, Boy Scout and Girl Guide groups and were distributed by Canadian Tire at their Winnipeg stores and at some Winnipeg Safeway stores. Advertisements were placed in the two Winnipeg daily newspapers and spot announcements were made on radio and T.V. Articles also appeared in the local weekly community newspapers. Staff from the Provincial Environment Department and Environment Canada appeared on a 1 hour open line show on CBC and the Prov. Minister of Environment, Workplace Safety and Healt appeared on the Peter Warren radio show. Personal contacts by staff of City, Prov. & Fed. agencies were also significant in making people aware of the project. One of the reasons for scheduling H.H.W. during Environment Week was to benefit from the usual publicity associated with this special week and all Environment Week releases included H.H.W. information. As well information on H.H.W. was made available at Environment Week social events.

Operation

Signs placed on adjacent main thoroughfares and on Tuxedo Avenue immediately in front of the complex directed participants onto the site through the Main South gate. It was decided that the North gate would only be used as an exit in the event of an emergency situation. One way street signs automatically routed vehicles to the "Traffic Director" who provided information to the driver, provided each with a copy of the Household Hazardous Waste Survey form and directed the vehicle to one of three available stations. The stations were wooden tables with a full complement of safety equipment available at each, and a wheeled cart for moving wastes from the station back to the tent area for sorting. Two 10' x 10' plastic tents were available to shelter two of the receiving stations in the event of rain.

It was decided that for safety reasons all wastes would be removed fro the vehicle by staff only. It was felt to be particularly important that children remain in the car. Plastic pails, absorbent material and poly bags we available in case a leaking container was encountered.

At the reception area under the large tent chemists sorted wastes according to various categories. Wastes that could be recycled such as used lube oil and batteries were directed to the designated areas on site. Wastes that were designated for out of province disposal moved to the Syntath staff who packaged, labelled and loaded their vehicle. Syntath was selected by a tendering process to accept wastes designated as requiring disposal at a dedicated hazardous waste disposal facility. They removed these wastes to their Ontario plant. A considerable quantity of household products such as cleaners, polishes, paint were in unopened original containers and obviously almost in "as purchased" condition. This material was set up on a special table and was available to Environmental Management staff, that is it was recycled by using it for its original intent.

Emptied containers, cardboard packaging material, dried out paint containers and other obviously innocuous type wastes were routed to landfill by placing in the on site bin.

Wastes, which it was determined could be safely sewered were either flushed down the manhole on the street with copious quantities of running water or were handled in the lab sink in Building two.

## Discussion

From the considerable number of articles appearing in Technical Journals of late it is evident that there is a lot of interest about HHW projects. A 1986 report prepared for EPA estimates that over the three previous years, more than 100 locally-sponsored household hazardous waste collection programs have been conducted.

As with most projects there are pros and cons for the holding of specific days for the collection of household hazardous wastes. Some of the "pros" are:

1. The wastes are kept out of the municipal landfill.

Some constituents of HHW will persist for considerable periods of time and could result in contamination of surface and groundwater. The volatile components may become part of the landfill gas associated with the decomposition of organic materials.

2. Wastes include more than just "Household" wastes as "Cottage Industry" wastes may also appear.

A number of operations which generate hazardous wastes may be carried on in the home. It would be highly likely that most of these wastes would end up in the same containers as used for other household waste. This could include photographic processing and developing chemicals, oil painting and various other craft operations.

3. Wastes are packaged, handled and identified properly during transport to disposal facilities.

Injuries have been documented that have affected refuse workers from the spill or release of materials contained in residential pick up which have included waste oil, battery acids, swimming pool chemicals, solvents and aerosol cans. In addition fires have damaged or destroyed collection vehicles from the mixing of chemicals or the rupturing of containers in the compaction cycle.

4. Wastes are not accessible prior to collection.

Many instances have been recorded where refuse cans have been tipped and contents spilled by domestic pets or children. Should hazardous wastes be set out by the householder for municipal pick up such spills could injure children or pets or damage property where the spill occurs.

5. Wastes don't present hazard to collectors or landfill operators.

If hazardous wastes are put out for municipal collection the likelihood of spills or mixing of incompatible hazardous wastes are high during the emptying of waste containers into the receiving vehicle. The collector may come into direct contact with harmful chemicals, may be subjected to fumes or explosions. Similarly at the waste disposal site landfill operational staff are in close proximity to the wastes being landfilled.

6. Recycling possibilities optimized.

Materials put out for municipal collection are lost as far as recovery and recycling. Wastes such as automobile batteries and waste oil when brought to an HHW collection point can be readily recycled.

Some of the "Cons" are:

1. Operating HHW days are expensive.

Total costs divided by quantities of waste collected produces a cost per drum disposed of that may be considered high. Aspects of the program such as education of the public, increased safety in the home through the removal of dangerous products, and protection of refuse collectors and landfill operators are difficult to attach dollar values to.

2. Hazards may be created by the movement of wastes from households to collection centres.

Information provided to householders as to acceptable wastes should reduce the amount of high hazard wastes moved by individuals. An information line at the Environment office allows citizens to discuss concerns prior to the collection days. Results from previous projects in many jurisdictions has not shown this to be a serious problem.

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# APPENDIX A

## Household Hazardous Waste Statistics

Number of Participants - 286

Volume of Waste Collected - 60 - 45 gal. drums

12,275 L

Volume of waste shipped to out-of-province Haz. Waste Disposal Co.

- 35 - 45 gal. drums

7,160 L

Used Oil collected and recycled - 1,364 L

Old Paint and Associated Products - 1,567 L

Pesticides received - Liquid 142 L

Solids 35 kg

# APPENDIX C

## MANITOBA HOUSEHOLD HAZARDOUS WASTE DAYS 1986 DETAILED INVENTORY

### ACIDS AND BASES

| | |
|---|---|
| 2.00 l | muriatic acid |
| 19.00 l | HCL |
| 200.00 gm | boric acid |
| 500.00 gm | SAF-acid |
| 700.00 gm | sulphamic acid |
| 1.00 kg | dry acid |
| 1.00 l | phosphoric acid |
| 1.00 l | perchloric acid |
| 1.33 l | sulphuric acid |
| 1.50 l | nitric acid |
| 2.00 l | acid |
| 2.50 l | acetic acid |
| 3.00 l | muriatic acid |
| 4.00 l | hydrochloric acid |
| 10.00 l | cleaning acid |
| 15.00 ml | hydrochloric acid |
| 25.00 ml | sulphuric acid |
| 50.00 ml | hydrofluoric acid |
| 150.00 ml | acid |
| 200.00 ml | hydrochloric acid |
| 200.00 ml | hydrofluoric acid |
| 500.00 ml | hydrofluoric acid |
| 300.00 gm | lye |

### ADHESIVES

| | |
|---|---|
| 500.00 gm | cement |
| 150.00 ml | plastic wood cement |
| 250.00 g | neoprine adhesive |
| 10.00 gm | contact cement |
| 100.00 gm | contact cement |
| 100.00 gm | contact cement |
| 200.00 gm | furnace cement |
| 200.00 gm | vinyl adhesive |
| 200.00 gm | wood cement |
| 250.00 gm | tile cement |
| 1.00 kg | air filter adhesive |
| 5.00 kg | adhesive |
| 0.25 l | plastic cement |
| 0.30 l | latex adhesive |
| 0.50 l | latex adhesive |
| 0.50 l | stucco adhesive |
| 1.00 l | cement S-700 |
| 1.00 l | asbestos tile cement |
| 1.00 l | adhesive |
| 1.00 l | wall tile cement |
| 1.00 l | linoleum cement |
| 1.00 l | adhesive |
| 1.00 l | fixer adhesive |
| 1.00 l | floor covering adhesive |
| 1.00 l | waterproof cement |
| 1.00 l | asbestos adhesive |
| 1.00 l | tile cement |
| 1.00 l | carpet adhesive |
| 1.00 l | adhesive |
| 1.00 l | Cement-S-25 |
| 2.00 l | roofing cement |
| 2.00 l | adhesive |
| 2.00 l | adhesive |
| 2.00 l | flooring glue |
| 3.00 l | carpet adhesive |
| 3.00 l | contact cement |
| 3.00 l | cement glue |
| 4.00 l | mastic |
| 4.00 l | ceramic tile mastic |
| 4.00 l | tile cement |
| 4.00 l | adhesive |
| 5.00 ml | contact cement |
| 15.00 ml | adhesive |
| 20.00 ml | adhesive |
| 30.00 ml | contact cement |
| 50.00 ml | adhesive solvent |
| 50.00 ml | contact cement |
| 100.00 ml | adhesive |
| 100.00 ml | wallpaper gum |
| 100.00 ml | epoxy glue |
| 100.00 ml | Interdecal adhesive |
| 100.00 ml | solvent cement |
| 100.00 ml | air seal adhesive |
| 100.00 ml | solvent cement |
| 200.00 ml | glue |
| 250.00 ml | contact cement |
| 300.00 ml | contact cement |
| 300.00 ml | contact cement |
| 500.00 ml | waterproof cement |
| 500.00 ml | vinyl adhesive |
| 500.00 ml | wallpaper glue |
| 0.00 [illegible] | liquid adhesive |
| 1.00 | liquid adhesive |

## AEROSOLS

| | |
|---|---|
| 500.00 mg | propane cylinder |
| 20.00 ml | aerosol cans |
| 100.00 ml | aerosol can |
| 0.00 x | oxygen gas |
| 0.00 x | acetylene gas cylinder |
| 0.00 x | aerosol paints (9 cans) |
| 100.00 gm | aerosol deodoriser |
| 200.00 gm | aerosol snow |
| 0.03 l | undercoating aerosol spray |
| 0.03 l | Make It Snow (aerosol product) |
| 0.62 l | aerosol cans |
| 50.00 ml | aerosol glass cleaner |
| 50.00 ml | shoe spray |
| 65.00 ml | shoe polish spray |
| 100.00 ml | aerosol disinfectant |
| 100.00 ml | aerosol cleanser |
| 200.00 ml | shoe polish (aerosol) |
| 200.00 ml | aerosol snow |
| 200.00 ml | aerosol shoe products |
| 220.00 ml | aerosol shaving cream |
| 300.00 ml | aerosol Endust |
| 300.00 ml | aerosol paint |
| 300.00 ml | aerosol silicon |
| 400.00 ml | aerosol Polystripper |
| 400.00 ml | aerosol Windex |
| 400.00 ml | aerosol shoe care product |
| 400.00 ml | hair spray |
| 500.00 ml | aerosol shoe spray |
| 500.00 ml | 2 aerosol shoe polish |
| 0.00 x | propane cylinder |
| 0.00 x | Scotchguard aerosol |
| 0.00 x | aerosol Moth Blaster |
| 0.00 x | aerosol de-icer |
| 0.00 x | aerosol air freshener |
| 1.00 x | propane tank |
| 1.00 x | propane tank |
| 1.00 x | propane tank |
| 1.00 x | aerosol Endust |
| 1.00 x | propane cylinder |
| 1.00 x | propane cylinder |
| 1.00 x | aerosol can |
| 1.00 x | aerosol oil |
| 2.00 x | propane cylinders |
| 2.00 x | aerosol cans |
| 3.00 x | spray bomb |
| 4.00 x | aersol spray cans |
| 6.00 x | propane cylinders |
| 13.00 x | aerosol cans |
| 15.00 x | aerosol cans |

## AUTOMOTIVE PRODUCTS

| | |
|---|---|
| 1.00 l | antifreeze |
| 2.00 l | antifreeze |
| 20.00 l | anti-freeze |
| 250.00 ml | axle grease |
| 0.00 x | ethylene glycol |
| 0.00 x | antifreeze |
| 100.00 gm | car paint |
| 200.00 gm | Quick Plug |
| 200.00 gm | Quick Start |
| 200.00 gm | Quick Start |
| 500.00 gm | lubricant |
| 500.00 gm | grease |
| 500.00 gm | body filler |
| 500.00 gm | body filler |
| 1000.00 gm | lubricant |
| 0.03 l | Quick Start spray |
| 0.09 l | hot fuel proof dope |
| 0.15 l | carburator cleaner |
| 0.22 l | brake fluid |
| 0.50 l | automatic transmission fluid |
| 0.50 l | antifreeze |
| 1.00 l | gas additives |
| 1.00 l | body filler |
| 1.00 l | transmission fluid |
| 1.00 l | power steering fluid |
| 1.00 l | tranmission fluid |
| 2.00 l | antifreeze |
| 2.00 l | antifreeze |
| 2.00 l | antifreeze |
| 2.00 l | antifreeze |
| 2.00 l | antifreeze |
| 2.50 l | antifreeze |
| 3.00 l | carburator cleaner |
| 5.00 l | ethylene glycol |
| 20.00 l | antifreeze |
| 200.00 l | used antifreeze |
| 250.00 l | brake fluid |
| 2.00 ml | graphite lubricant |
| 20.00 ml | ready mix aluminum |
| 30.00 ml | de-icer |
| 50.00 ml | grease |
| 50.00 ml | gas line antifreeze |
| 100.00 ml | spark plug cleaner |
| 100.00 ml | 3 in 1 oil |
| 100.00 ml | car polish |
| 100.00 ml | grease |
| 100.00 ml | tire spray |
| 100.00 ml | antifreeze |
| 100.00 ml | gas line antifreeze |
| 200.00 ml | Stop Leak |
| 200.00 ml | car polish |
| 200.00 ml | brake fluid |
| 200.00 ml | brake fluid |
| 227.00 ml | brake fluid |
| 300.00 ml | transmission fluid |
| 300.00 ml | brake fluid |
| 500.00 ml | gasoline antifreeze |
| 500.00 ml | car wax |
| 500.00 ml | auto polish |
| 500.00 ml | car wax |
| 500.00 ml | brake fluid |
| 500.00 ml | mag wheel cleaner |
| 500.00 ml | gear lubricant |
| 750.00 ml | brake fluid |
| 900.00 ml | Quick Start |
| 0.00 x | gas tank |
| 0.00 x | antifreeze |
| 0.00 x | radiator cleaner |
| 1.00 x | oil filter |
| 1.00 x | tire repair kit |

## BATTERIES

46 Lead/Acid Batteries

## CHEMICALS

| | | |
|---|---|---|
| 100.00 | gm | sulpher |
| 500.00 | gm | cadmium salts |
| 45.00 | kg | calcium hypochloride (Burn Out) |
| 5.00 | l | film developing chemicals |
| 200.00 | ml | emulsifier |
| 15.00 | gm | palladium |
| 25.00 | gm | triphenyl methylchloride |
| 25.00 | gm | triphenyl methylbromide |
| 25.00 | gm | methyl glucoside |
| 25.00 | gm | rosanitrine hydrochloride |
| 50.00 | gm | triacetoglucal |
| 50.00 | gm | glucose pentacetate |
| 50.00 | gm | cerium ammonium nitrate |
| 50.00 | gm | alkaline iodide-azide |
| 100.00 | gm | sulphur |
| 100.00 | gm | sulphur |
| 100.00 | gm | bluestone |
| 100.00 | gm | methylglucamine |
| 100.00 | gm | sodium acetate |
| 100.00 | gm | methyl mannopyranose |
| 100.00 | gm | pthalimide |
| 100.00 | gm | rosanitrine chloride |
| 100.00 | gm | antimony trichloride |
| 100.00 | gm | arsenic |
| 100.00 | gm | manganous sulphate |
| 100.00 | gm | p-rosanitrine base |
| 100.00 | gm | o-toldine dihydrochloride |
| 200.00 | gm | arsenic |
| 200.00 | gm | sodium dichromate |
| 200.00 | gm | potassium ferrocyanide |
| 200.00 | gm | versene |
| 250.00 | gm | arabinose |
| 250.00 | gm | potassium permanganate |
| 500.00 | gm | potassium dichromate |
| 500.00 | gm | arsenious oxide |
| 725.00 | gm | sodium borohydride |
| 725.00 | gm | glucosamine hydrochloride |
| 0.50 | kg | Ca(CN)2 |
| 1.00 | kg | white lead paste |
| 2.00 | kg | phenol |
| 0.50 | l | sodium silicate |
| 1.00 | l | ammonia |
| 1.00 | l | carbon tet. |
| 1.00 | l | zinc naphthate |
| 1.00 | l | ethyl acetate |
| 2.00 | l | sodium hypo cl |
| 2.00 | l | 2-MCPA amine |
| 18.00 | l | 4 containers ammonia hydroxide |
| 41.00 | l | fixer for xrays |
| 51.00 | l | developer for xrays |
| 99.00 | l | chromate (boiler treatment chemical) |
| 10.00 | ml | foaming agent |
| 50.00 | ml | nicotine sulphate |
| 50.00 | ml | chrome |
| 100.00 | ml | chloral hydrate |
| 100.00 | ml | benedryl |
| 300.00 | ml | wood preservative |
| 300.00 | ml | freon |
| 400.00 | ml | acrylic catalyst |
| 500.00 | ml | HCl |
| 500.00 | ml | ammonia |
| 600.00 | ml | carbon tetrachloride |
| 750.00 | ml | ferric chloride |
| [illegible] | | broken thermometer |

## RADIOACTIVES

4 x Smoke Detectors

## CLEANERS

| | |
|---|---|
| 2.00 kg | furniture shampoo |
| 2.00 kg | soap |
| 50.00 ml | upholstery shampoo |
| 20.00 gm | silver polish |
| 50.00 gm | brush cleaner |
| 70.00 gm | aluminum cleaner |
| 100.00 gm | rug cleaner |
| 100.00 gm | oven cleaner |
| 100.00 gm | stainless steel cleaner |
| 100.00 gm | Drano |
| 200.00 gm | oven cleaner |
| 285.00 gm | oven cleaner |
| 300.00 gm | hand cleaner |
| 400.00 gm | upholstery shampoo |
| 400.00 gm | window cleaner |
| 500.00 gm | Drano |
| 680.00 gm | rug cleaner |
| 1.00 kg | rug cleaner |
| 0.12 l | metal cleaner |
| 0.25 l | chrome polish |
| 0.50 l | floor cleaner |
| 0.75 l | floor cleaner |
| 0.75 l | rug shampoo |
| 1.00 l | stainless steel cleaner |
| 1.00 l | drain cleaner |
| 1.00 l | aluminum cleaner |
| 1.00 l | drain opener |
| 1.00 l | cleaner |
| 1.00 l | aluminum cleaner |
| 1.00 l | liquid cleaner |
| 3.00 l | floor wax cleaner |
| 4.00 l | cleaner |
| 10.00 ml | Drano |
| 10.00 ml | cleaner |
| 10.00 ml | Woolite |
| 10.00 ml | cleaner |
| 30.00 ml | dry cleaner |
| 50.00 ml | Lysol spray |
| 50.00 ml | glass cleaner |
| 50.00 ml | window cleaner |
| 50.00 ml | Drano |
| 50.00 ml | fabric cleaner |
| 50.00 ml | spray cleaner |
| 50.00 ml | cleaner conditioner |
| 50.00 ml | ammonia cleaner |
| 50.00 ml | detergent |
| 50.00 ml | Lestoil |
| 100.00 ml | wall cleaner |
| 100.00 ml | oven cleaner aerosol |
| 100.00 ml | cleaner |
| 100.00 ml | chrome cleaner |
| 100.00 ml | shampoo |
| 100.00 ml | rug shampoo |
| 110.00 ml | shampoo |
| 200.00 ml | Pinesol |
| 200.00 ml | steam iron cleaner |
| 200.00 ml | rust remover |
| 200.00 ml | carpet shampoo |
| 200.00 ml | floor cleaner |
| 200.00 ml | carpet cleaner |
| 200.00 ml | Easy-Off |
| 200.00 ml | oven cleaner |
| 200.00 ml | aerosol cleaner |
| 300.00 ml | oven cleaner |
| 300.00 ml | hardwood floor cleaner |
| 300.00 ml | tile cleaner |
| 400.00 ml | wax stripper |
| 400.00 ml | mildew cleaner |
| 400.00 ml | oven cleaner |
| 400.00 ml | Lysol |
| 473.00 ml | oven cleaner |
| 500.00 ml | tile cleaner |
| 500.00 ml | fabric cleaner |
| 500.00 ml | upholstery shampoo |
| 500.00 ml | floor cleaner |
| 500.00 ml | wood cleaner |
| 500.00 ml | oven cleaner |
| 600.00 ml | tile cleaner |
| 750.00 ml | glass cleaner |
| 500.00 ml | chrome cleaner |
| 0.00 x | lysol (1 can) |
| 0.00 x | 1 box S.O.S. pads |
| 0.00 x | toilet bowl cleaner |
| | |
| 1.00 x | aerosol oven cleaner |

## DRUGS

| | |
|---|---|
| 250.00 gm | drugs |
| 2.00 kg | assorted drugs |
| 0.00 x | assorted drugs |
| 10.00 x | drugs |
| 80.00 kg | drugs (expirec.some controlled) |
| 30.00 ml | Calamine lotion |
| 100.00 ml | liniment |
| 0.00 x | assorted drugs |
| 0.00 x | codeine (tablets) |
| 0.00 x | aspirin tablets |

## FLAMMABLES

| | |
|---|---|
| 1.00 l | camp fuel |
| 2.00 l | unknown solvent |
| 4.50 l | varsol |
| 9.00 l | volitile solvent |
| 13.50 l | solvent/gas mix |
| 16.00 l | contact cement/fuel oil/mineral spirits |
| 58.00 l | gas/cycle oil/algae mixture |
| 20.00 ml | thinner |
| 170.00 ml | lighter fluid |
| 300.00 ml | solvent |
| 500.00 ml | gasoline |
| 600.00 ml | gas |
| 50.00 gm | fire starter |
| 50.00 gm | cooking fuel |
| 100.00 gm | butane fuel |
| 200.00 gm | Zip |
| 500.00 gm | BBQ start |
| 2.50 kg | ether |
| 22.50 kg | gasoline (oil mixed) |
| 0.03 l | methyl alcohol |
| 0.09 l | methyl alcohol |
| 0.15 l | charcoal lighter fuel |
| 0.50 l | starter fluid |
| 0.50 l | charcoal starter |
| 0.50 l | Coleman fuel |
| 1.00 l | kerosene |
| 1.00 l | BBQ lighter fluid |
| 1.00 l | fire starter |
| 1.00 l | paint thinner |
| 1.00 l | camping fuel |
| 1.00 l | BBQ fluid |
| 2.00 l | Coleman fuel |
| 2.00 l | gas |
| 2.00 l | airplane fuel |
| 3.00 l | camping fuel |
| 3.00 l | solvent |
| 3.00 l | varsol |
| 3.00 l | turpentine/fuel mixture |
| 3.00 l | paint thinner |
| 4.00 l | charcoal lighter |
| 4.00 l | Coleman fuel |
| 4.00 l | cleaning solvent |
| 4.00 l | thinner |
| 5.00 l | BBQ fuel |
| 5.00 l | varsol |
| 6.00 l | varsol |
| 15.00 l | gasoline |
| 15.00 l | gas |
| 72.00 l | fuel oil |
| 10.00 ml | varsol |
| 10.00 ml | methal hydrate |
| 10.00 ml | camping fuel |
| 10.00 ml | paint thinner |
| 15.00 ml | starter fluid |
| 20.00 ml | butane |
| 25.00 ml | methyl hydrate |
| 25.00 ml | acetone |
| 30.00 ml | isopropyl alcohol |
| 50.00 ml | lighter fluid |
| 50.00 ml | lighter fluid |
| 100.00 ml | coal oil |
| 100.00 ml | lacquer thinner |
| 100.00 ml | charcoal lighter |
| 100.00 ml | camphorated oil |
| 100.00 ml | paint thinner |
| 200.00 ml | lighter fuel |
| 200.00 ml | comp fuel |
| 200.00 ml | lacquer thinner |
| 200.00 ml | paint thinner |
| 300.00 ml | Coleman fuel |
| 300.00 ml | lighter fluid |
| 500.00 ml | contact cement cleaner |
| 500.00 ml | methyl hydrate |
| 500.00 ml | charcoal lighter |
| 500.00 ml | BBQ lighter fluid |
| 500.00 ml | solvent |
| 500.00 ml | charcoal lighter |
| 500.00 ml | paint thinner |
| 500.00 ml | coal oil |
| 600.00 ml | petroleum ether |
| 700.00 ml | rubbing alcohol |
| 0.00 x | Varsol |
| 0.00 x | fire starter fuel |
| 0.00 x | ignition starter |
| 1.00 x | lighter |

## PAINTS

| | |
|---|---|
| 2,099.68 | Litres of Paint |
| 4.27 | Kgs of Paint |
| 32 | Items of Paint |

## OILS

| | |
|---|---|
| 1,439.25 | Litres of Used Oil |

## HOUSEHOLD PRODUCTS

| | | |
|---|---|---|
| 4.00 | l | ashphalt |
| 20.00 | ml | cement sealer |
| 50.00 | ml | stain wax |
| 100.00 | ml | liquid wax |
| 100.00 | ml | plumbing compound |
| 100.00 | ml | silver polish |
| 200.00 | ml | wood preservative |
| 500.00 | ml | tar |
| 500.00 | ml | fiberglass |
| 0.00 | x | cleaning solutions |
| 10.00 | gm | Drano |
| 20.00 | gm | dye |
| 25.00 | gm | dye |
| 37.00 | gm | shoe polish |
| 50.00 | gm | art fixitive |
| 50.00 | gm | putty |
| 50.00 | gm | shoe polish |
| 70.00 | gm | wall sizing |
| 100.00 | gm | Anti-Fog (eyeglasses) |
| 100.00 | gm | disinfectant |
| 100.00 | gm | adhesive tape remover |
| 100.00 | gm | Polygrip |
| 100.00 | gm | solvent cement |
| 100.00 | gm | grease |
| 100.00 | gm | vinyl wall covering |
| 100.00 | gm | wax |
| 150.00 | gm | lye |
| 150.00 | gm | shoe polish |
| 200.00 | gm | concrete waterproof |
| 200.00 | gm | 2 wax candles |
| 200.00 | gm | laundry starch |
| 200.00 | gm | wallpaper paste |
| 200.00 | gm | wine making supplies |
| 200.00 | gm | asphalt |
| 200.00 | gm | caulking compound |
| 200.00 | gm | starch |
| 200.00 | gm | wax |
| 250.00 | gm | wood filler |
| 250.00 | gm | wax |
| 250.00 | gm | wood filler |
| 300.00 | gm | plastic wood |
| 400.00 | gm | Dextrose |
| 500.00 | gm | glucose |
| 500.00 | gm | assorted cosmetics |
| 500.00 | gm | laundry starch |
| 600.00 | gm | starch |
| 670.00 | gm | plastic wood |
| 700.00 | gm | soil conditioner |
| 700.00 | gm | plastic cement |
| 1000.00 | gm | Drano |
| 0.25 | kg | putty |
| 1.00 | kg | wood preservatives |
| 1.00 | kg | tile grout |
| 1.00 | kg | deodorizer |
| 1.00 | kg | patching compound |
| 1.50 | kg | joint filler |
| 2.00 | kg | cement |
| 2.50 | kg | joint fillller |
| 40.00 | kg | 20-10-5 fertilizer |
| 100.00 | kg | floor wax |
| 2.50 | kg5 | asbestos based sealing crysol |
| 0.03 | l | silicone seal |
| 0.25 | l | plant food |
| 0.25 | l | black dye |
| 0.50 | l | kettle descaler |
| 0.50 | l | deodorizer |
| 0.50 | l | water repellant |
| 0.50 | l | jelly rust remover |
| 0.50 | l | sealer |
| 0.50 | l | sealer |
| 0.50 | l | dog repellant |
| 0.71 | l | silicone rubber |
| 1.00 | l | floor polish |
| 1.00 | l | wax stripper |
| 1.00 | l | caulking cement |
| 1.00 | l | stucco |
| 1.00 | l | latex sealer |
| 1.00 | l | fire extinguisher (carbon tet) |
| 1.00 | l | rust preventative |
| 1.00 | l | wood preservative |
| 1.00 | l | canvas waterproofing |
| 1.00 | l | sanding sealer |
| 1.00 | l | wallpaper sizing |
| 2.00 | l | roofing cement |
| 2.00 | l | wax stripper |
| 2.00 | l | stain |
| 2.00 | l | wood preservative |
| 2.00 | l | wax |
| 2.50 | l | preservative |
| 3.00 | l | plastic cement |
| 3.00 | l | reducer |
| 3.00 | l | water seal |
| 4.00 | l | driveway sealer |
| 4.00 | l | stucco |
| 4.00 | l | wax |
| 4.50 | l | creosote wood preservative |
| 5.00 | l | brick coat |
| 5.00 | l | tar |
| 18.00 | l | driveway tar |
| 40.00 | l | spray resin |
| 100.00 | l | metal leaf finish |
| 1.00 | ml | plaster |
| 5.00 | ml | leather dye |
| 10.00 | ml | porcelain repair |
| 10.00 | ml | adhering liquid |
| 10.00 | ml | spray wax |
| 10.00 | ml | liquid hardener |
| 20.00 | ml | shoe conditioner |
| 20.00 | ml | plastic cement |
| 20.00 | ml | nail polish |
| 30.00 | ml | mousse |
| 50.00 | ml | saddle soap |
| 50.00 | ml | deodorizer |
| 50.00 | ml | hair spray |
| 50.00 | ml | wood sealer |
| 50.00 | ml | sizing |
| 50.00 | ml | polish |
| 50.00 | ml | metal polish |
| 50.00 | ml | deodorant |
| 50.00 | ml | Kettle Klean scale remover |
| 50.00 | ml | plastic wood |
| 50.00 | ml | blueing |
| 60.00 | ml | wax |
| 100.00 | ml | stain |

## HOUSEHOLD PRODUCTS (cont'd)

| | |
|---|---|
| 100.00 ml | liquid blueing |
| 100.00 ml | liquid plastic |
| 100.00 ml | wood polish |
| 100.00 ml | dog repulsion |
| 100.00 ml | furniture polish |
| 100.00 ml | shoe polish |
| 100.00 ml | silicon compound |
| 100.00 ml | spice |
| 100.00 ml | blue |
| 100.00 ml | rust remover |
| 100.00 ml | insect pet repellant |
| 100.00 ml | snow seal |
| 100.00 ml | plastic wood |
| 100.00 ml | wood sealer |
| 100.00 ml | wallpaper remover |
| 100.00 ml | woodcraft |
| 100.00 ml | liquid silicon |
| 100.00 ml | solvent cement |
| 120.00 ml | soldering fuux |
| 140.00 ml | plastis wood |
| 200.00 ml | plastic wood |
| 200.00 ml | Lockease |
| 200.00 ml | rust preventative |
| 200.00 ml | Reddi Starch |
| 200.00 ml | hair conditioner |
| 200.00 ml | floor wax |
| 200.00 ml | silicone sealer fluid |
| 200.00 ml | rust remover |
| 200.00 ml | wood finish |
| 200.00 ml | shoe care products |
| 200.00 ml | hair dye |
| 200.00 ml | deodorant (septic) |
| 200.00 ml | stain sealer |
| 200.00 ml | putty |
| 200.00 ml | Polystripper |
| 200.00 ml | vinyl filler |
| 300.00 ml | penetem protective coating |
| 300.00 ml | stain remover |
| 300.00 ml | preservative |
| 300.00 ml | hair conditioning supplies |
| 300.00 ml | silicone lubricant |
| 400.00 ml | liquid starch |
| 473.00 ml | photo solution (NaOH) |
| 500.00 ml | household spray |
| 500.00 ml | wax |
| 500.00 ml | wax |
| 500.00 ml | liquid blueing |
| 500.00 ml | friction reducer |
| 500.00 ml | ski wax |
| 500.00 ml | floor polish |
| 500.00 ml | Old Spice aftershave |
| 500.00 ml | steam iron conditioner |
| 500.00 ml | shoe polish |
| 500.00 ml | polish |
| 500.00 ml | deoderizer |
| 1300.00 ml | wax stripper |
| 0.00 x | caulking |
| 1.00 x | fire extinguisher |

## PESTICIDES

| | |
|---|---|
| 0.46 l | black leaf 40 |
| 500.00 ml | 2-4-D |
| 150.00 gm | insecticides |
| 200.00 gm | bordeaux mixture |
| 0.50 kg | Hivor X-L soil sterilant |
| 0.50 kg | DDT powder |
| 3.00 kg | DDT and killex |
| 10.00 kg | 1 bag DDT powder |
| 4.00 l | System A80EC insecticide |
| 500.00 ml | aerosol insecticide (unknown) |
| 1.00 x | weedex |
| 10.00 gm | Captan |
| 50.00 gm | DDT |
| 50.00 gm | chloradane |
| 50.00 gm | 2-4-D |
| 50.00 gm | Aldrin |
| 50.00 gm | methoxy |
| 50.00 gm | insecticide |
| 50.00 gm | chlordane |
| 50.00 gm | Diazinon |
| 50.00 gm | Deritox |
| 100.00 gm | carbaryl/zinc |
| 100.00 gm | rose dust |
| 100.00 gm | Deritox |
| 100.00 gm | insecticide cream |
| 100.00 gm | 2-4-D |
| 100.00 gm | diazinon |
| 100.00 gm | insecticide |
| 100.00 gm | weed killer |
| 100.00 gm | deritox |
| 100.00 gm | grass killer |
| 100.00 gm | chlordane |
| 200.00 gm | Slug-EMI |
| 200.00 gm | rose spray |
| 200.00 gm | insecticide |
| 200.00 gm | chlorodine 5% |
| 200.00 gm | vegetable dust |
| 200.00 gm | rose dust |
| 250.00 gm | deazinon |
| 250.00 gm | Orthene (insecticide) |
| 300.00 gm | moth insecticide |
| 300.00 gm | DDT |
| 350.00 gm | Vendex 50w |
| 400.00 gm | insectide |
| 462.00 gm | Raid |
| 500.00 gm | insecticide |
| 500.00 gm | Tanglefoot |
| 500.00 gm | 16% deri-dust |

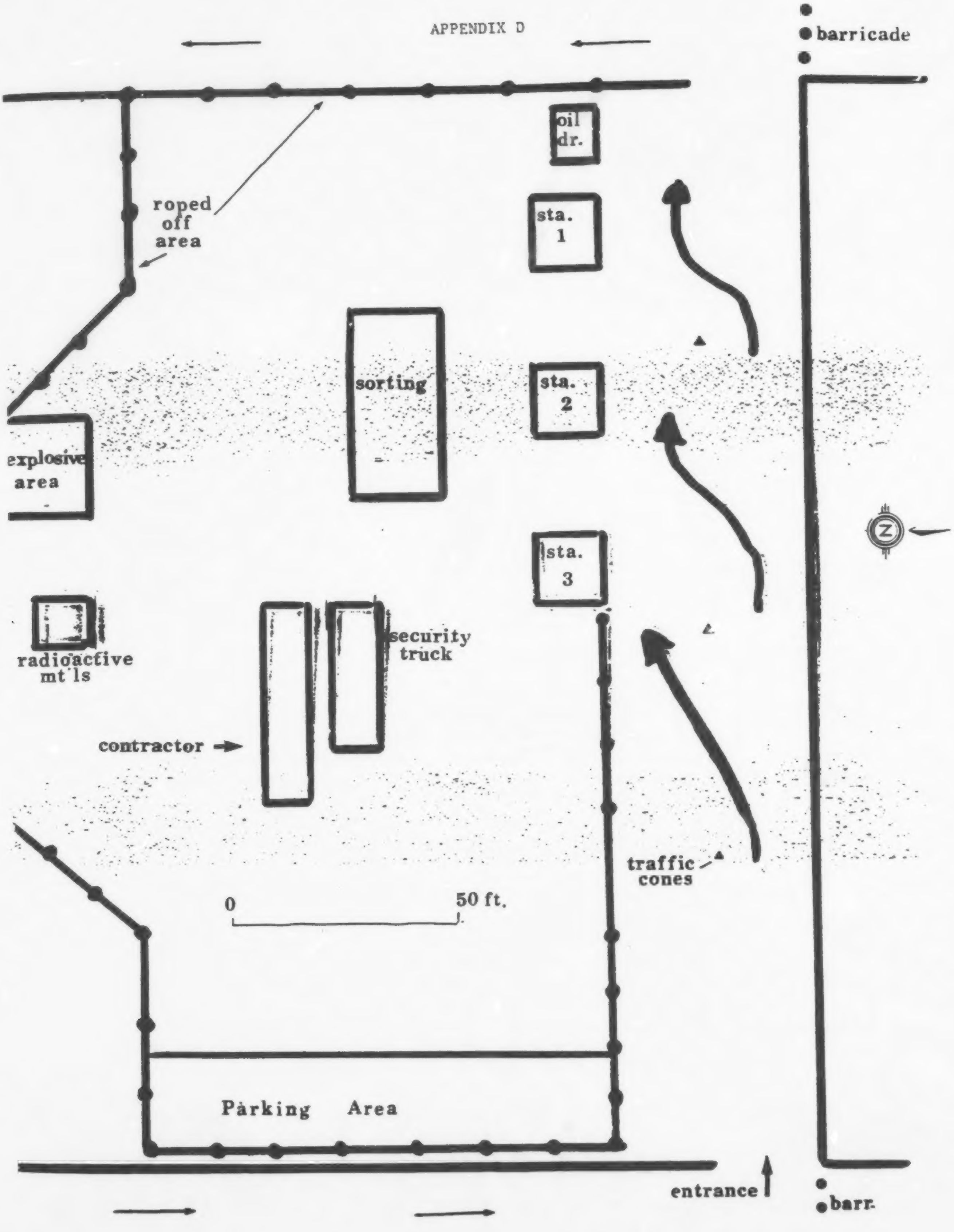
## PESTICIDES (cont'd)

| | |
|---|---|
| 500.00 gm | Dowpon |
| 600.00 gm | Agrispray |
| 700.00 gm | DDT |
| 750.00 gm | Deritox (insecticide) |
| 0.50 kg | DDT (solid) |
| 0.50 kg | Dowpon |
| 0.50 kg | Rotenone |
| 1.00 kg | Morestan (miticide) |
| 1.00 kg | DDT |
| 1.00 kg | soil sterilizer (arsenic) |
| 1.50 kg | Orthocide 50 |
| 2.00 kg | Temik |
| 2.00 kg | Maneb |
| 2.00 kg | Temik Aldecarb |
| 2.50 kg | Dacthal |
| 2.50 kg | DDT 3% |
| 0.06 l | insecticide |
| 0.25 l | 2-4- D |
| 0.50 l | Raid insecticide |
| 0.75 l | malathion |
| 1.00 l | 2-4-D |
| 1.00 l | DDT 25% |
| 1.00 l | malathion |
| 1.00 l | 2-4-D |
| 1.00 l | DDT |
| 2.00 l | DDT |
| 2.00 l | aerosol Off |
| 2.00 l | Killex |
| 3.00 l | Killex |
| 3.00 l | DDT |
| 4.00 l | malathion |
| 4.00 l | DDT liquid |
| 4.00 l | Bromox 450M (herbicide) |
| 4.50 l | 25% DDT emulsion |
| 4.50 l | DDT |
| 4.50 l | malathion |
| 6.50 l | Kelthane (miticide) |
| 8.00 l | 2-4-D |
| 15.75 l | Deldrin |
| 20.00 l | DDT |
| 25.00 l | Buctril |
| 25.00 l | Asulox F |
| 10.00 ml | aerosol Off |
| 10.00 ml | 2-4-D and 2-4-5-T |
| 10.00 ml | 2-4-D |
| 10.00 ml | Raid |
| 25.00 ml | Slug-it |
| 25.00 ml | malathion |
| 50.00 ml | Off repellant |
| 50.00 ml | Killex |
| 50.00 ml | malathion |
| 50.00 ml | aerosol insecticide |
| 50.00 ml | Cyclon 2E (insecticide) |
| 50.00 ml | Weed-All |
| 100.00 ml | malathion |
| 100.00 ml | Killex |
| 100.00 ml | Killex |
| 100.00 ml | Raid insecticide |
| 100.00 ml | aerosol insecticide |
| 100.00 ml | aerosol Raid |
| 100.00 ml | Killex |
| 200.00 ml | DDT (liquid) |
| 200.00 ml | Killex |
| 200.00 ml | malathion |
| 200.00 ml | aerosol insecticides |
| 200.00 ml | malathon |
| 200.00 ml | Weedrite |
| 200.00 ml | 2-4-D liquid |
| 200.00 ml | moth bomb |
| 200.00 ml | malathion |
| 200.00 ml | Killex |
| 200.00 ml | aerosol insecticide |
| 200.00 ml | malathion |
| 250.00 ml | pesticides:sevin,diazinon |
| 250.00 ml | 2-4-D |
| 300.00 ml | aerosol insectide |
| 300.00 ml | Killex weed killer |
| 300.00 ml | 2-4-D (leaking) |
| 300.00 ml | DDT (liquid) |
| 300.00 ml | Killex |
| 300.00 ml | aerosol insecticide |
| 300.00 ml | Gardol (fungicide) |
| 300.00 ml | chloredane |
| 400.00 ml | liquid insecticide |
| 400.00 ml | Gardol |
| 500.00 ml | Diazinon |
| 500.00 ml | diazinon |
| 500.00 ml | fungicide |
| 500.00 ml | 2-4-D |
| 500.00 ml | chlordane 40% |
| 500.00 ml | DDT 2.5% |
| 500.00 ml | malathion |
| 500.00 ml | DDT (spray bombs) |
| 500.00 ml | insecticide (Carbinal,2 cans) |
| 500.00 ml | DDT 25% (liquid) |
| 500.00 ml | Weed-All |
| 500.00 ml | malathion |
| 500.00 ml | Ortho crab grass killer |
| 700.00 ml | DDT (liquid) |
| 750.00 ml | pyrethrin |
| 1500.00 ml | Cygon 2E |
| 0.00 x | 2 boxes mosquito coils |
| 0.00 x | aerosol insecticide |
| 1.00 x | Weedex bar |
| 1.00 x | aerosol Spray-Lac |
| 1.00 x | weedex bar |
| 1.00 x | weedex bar |
| 2.00 x | ant traps |
| 2.00 x | aerosol Raid |
| 4.00 | weedex bars |

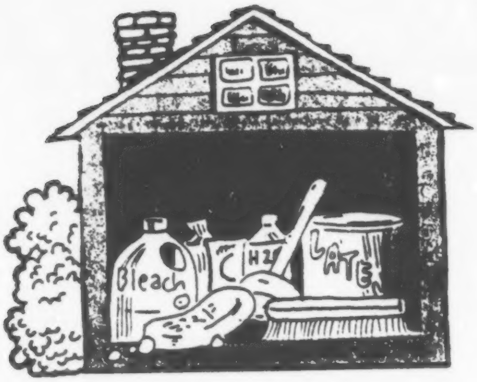
## UNKNOWNS

37 Unidentified Containers

## APPENDIX D


barricade
oil dr.
roped off area
sta. 1
sorting
sta. 2
explosive area
sta. 3
radioactive mt'ls
security truck
contractor
traffic cones
0
50 ft.
Parking Area
entrance
barr.
Z

APPENDIX E



# A Safer Alternative

Many home and garden products contain harmful chemicals, which can cause serious injury to human health and the environment. As a result, more and more people are switching to less toxic products.

Reduce your exposure to toxic chemicals and reduce the amount of hazardous waste going to landfills and sewer systems by switching now!

## What Can You Do?

| Instead of this Household Product | Use this Safer Alternative |
|---|---|
| **Aerosol Sprays** | Use rolls-ons, creams, sticks and non-aerosols. The propellants used in most aerosols and many products are particularly hazardous since the small droplets produced lodge deep in the lungs. |
| **Air Freshener** | Air fresheners work by masking one odor with another, or by dulling the sense of smell. Ventilate with fresh air, or in small areas, leave opened box of baking soda or dish filled with vinegar to absorb odors. |
| **Aluminum Cleaner** | Most commercial aluminum cleaners contain acids. To safely clean stained aluminum, mix 500 ml (1 cup) non-abrasive laundry detergent in 10 L (2-1/2 gal) water and scrub with a stiff bristled brush. Rinse well. |
| **Chemical Fertilizer** | Use compost (leaves, grass clippings, manure) to improve the productivity of the soil. |
| **Detergent** | Use soap instead of detergent. Soap is an excellent cleaner in soft water, is relatively nontoxic and is biodegradable. Detergents leave residues in clothing which require fabric softeners to mask. |
| **Disinfectant** | Dilute bleach makes a good all-purpose cleaner and disinfectant. Do **not** add ammonia to this mixture as a toxic gas is produced. |
| **Drain Opener** | Drain cleaners can cause severe burns. To unclog drains, try pouring boiling water down the drain. If this fails, use a plunger or a metal snake. To prevent drain clogging, keep grease, hair, etc. out of the drain. |

ROLL-ON
SOAP
LATEX
House Paint
H·2·O
Bleach

| | |
|---|---|
| **Garden Insecticides** | Insecticides are toxic chemicals. To control garden pests, try planting strong-smelling herbs such as basil, chives, garlic, sage and onions, and flowers such as chrysanthemums and marigolds with your vegetables. To control caterpillars, use a bacterial insecticide such as Dipel which will kill the caterpillars, yet is harmless to humans and pets. If absolutely necessary, use a biodegradable insecticide such as a pyrethrum. |
| **Herbicides** | Herbicides are toxic chemicals. Handpick weeds in the garden or use a mulch around plants to prevent weed growth. Maintaining a healthy lawn will also keep weeds to a minimum. |
| **Household Insecticides** | Spray or wash plants with soapy water (not detergents), then rinse. To shine the leaves, wash them with diluted milk. |
| **Liquid Cleaner** | Mix 120 ml (1/4 cup) ammonia and 120 ml (1/4 cup) washing soda in 2 L (2 qt) of warm water to make a good general purpose household cleaner. Do **not** add chlorine bleach to this mixture as a toxic gas is produced. |
| **Mildew Proofing** | Ventilating to reduce humidity and increasing the temperature will prevent mildew growth. Mildew stains on cloth can be removed by moistening the stain with lemon juice, sprinkling with salt and drying in the sun. Dilute bleach will also remove mildew stains. |
| **Moth Balls** | Keep clothes well cleaned and vacuum closets frequently. Store woolens in chests or closets constructed of strongly fragrant cedar. |
| **Oven Cleaner** | Clean oven spills as they happen. Sprinkle salt on spills when warm and scrub. Use oven cleaners that don't contain caustic cleaners. |
| **Paints – Oil, Enamel** | Use latex or water-based paints if possible. You will reduce your exposure to toxic fumes from the paint, paint thinners and solvents. |
| **Scouring Powder** | Use baking soda. It is non-abrasive and non-irritating to the skin. |
| **Toilet Bowl Cleaner** | Most toilet bowl cleaners can cause severe burns. You can clean the bowl with a toilet brush and baking soda. To disinfect, pour 250 ml (1/2 cup) of bleach in the bowl. |
| **Window Cleaner** | An inexpensive and safe window cleaner can be made at home. Mix 120 ml (1/4 cup) vinegar in 2 L (2 qt) water, spray on the window and wipe with newspaper to shine the glass. |

These are a few examples of safer and cheaper alternatives for some common household products. For further information, please contact: Environment Canada, 800-275 Portage Avenue, Winnipeg, Manitoba, R3B 2B3, Phone: 949-4813.

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A Joint endeavour by:

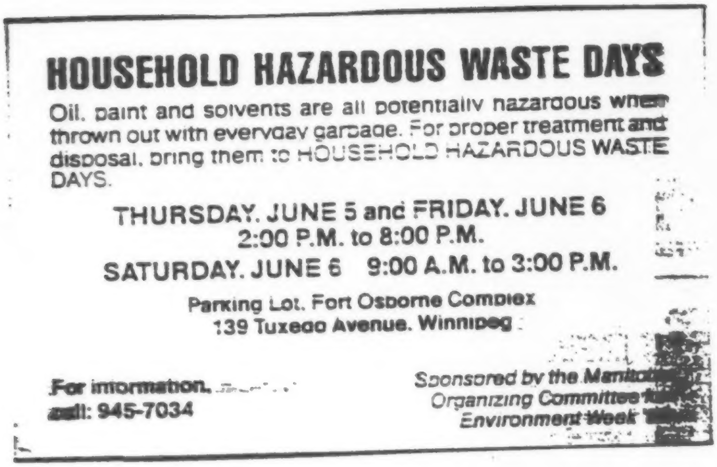
• Environment Canada • Manitoba Environment and Workplace Safety and Health • The City of Winnipeg

CANADIAN
ENVIRONMENT
WEEK

Sponsored by the Manitoba Organizing Committee
for Environment Week '86.

MG-13880

ROLL-ON
SOAP
LATEX
House paint
H2O
Bleach
Safe Detergent



## HOUSEHOLD HAZARDOUS WASTE DAYS

Oil, paint and solvents are all potentially hazardous when thrown out with everyday garbage. For proper treatment and disposal, bring them to HOUSEHOLD HAZARDOUS WASTE DAYS.

THURSDAY, JUNE 5 and FRIDAY, JUNE 6
2:00 P.M. to 8:00 P.M.
SATURDAY, JUNE 6 9:00 A.M. to 3:00 P.M.

Parking Lot, Fort Osborne Complex
139 Tuxedo Avenue, Winnipeg

For information,
call: 945-7034

*Sponsored by the Manito*
*Organizing Committee*
*Environment Week*

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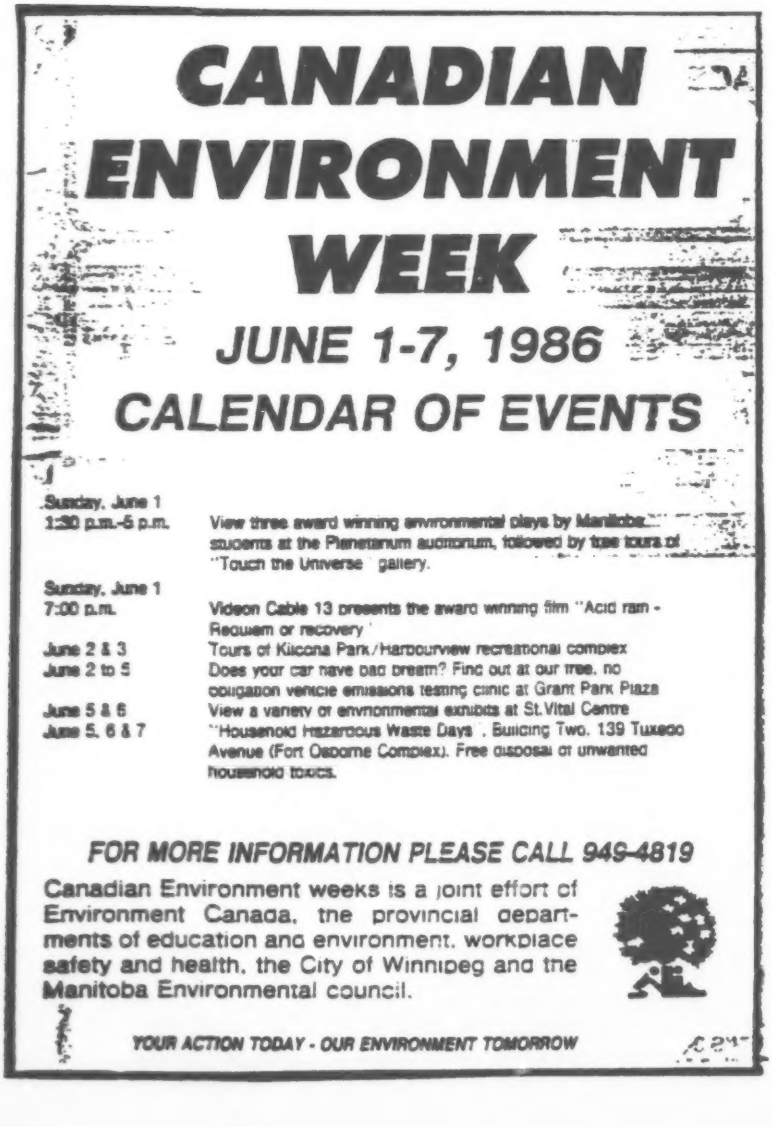

# CANADIAN ENVIRONMENT WEEK

## JUNE 1-7, 1986

## CALENDAR OF EVENTS

| | |
|---|---|
| Sunday, June 1<br>1:30 p.m.-5 p.m. | View three award winning environmental plays by Manitoba students at the Planetarium auditorium, followed by free tours of "Touch the Universe" gallery. |
| Sunday, June 1<br>7:00 p.m. | Videon Cable 13 presents the award winning film "Acid rain - Requiem or recovery" |
| June 2 & 3 | Tours of Kilcona Park/Harbourview recreational complex |
| June 2 to 5 | Does your car have bad breath? Find out at our free, no obligation vehicle emissions testing clinic at Grant Park Plaza |
| June 5 & 6 | View a variety of environmental exhibits at St.Vital Centre |
| June 5, 6 & 7 | "Household Hazardous Waste Days". Building Two, 139 Tuxedo Avenue (Fort Osborne Complex). Free disposal of unwanted household toxics. |

***FOR MORE INFORMATION PLEASE CALL 949-4819***

Canadian Environment weeks is a joint effort of Environment Canada, the provincial departments of education and environment, workplace safety and health, the City of Winnipeg and the Manitoba Environmental council.

***YOUR ACTION TODAY - OUR ENVIRONMENT TOMORROW***

APPENDIX G

CANADIAN
ENVIRONMENT
WEEK

SEMAINE
CANADIENNE DE
L'ENVIRONNEMENT

You are cordially invited to attend opening ceremonies for

"WINNIPEG HOUSEHOLD HAZARDOUS WASTE DAYS"

2:00 p.m., Thursday, June 5, 1986

Parking Lot, Fort Osborne Complex
139 Tuxedo Avenue, Winnipeg

Manitoba Environment and Workplace Safety and Health Minister, Gerard Lecuyer, Winnipeg Mayor Bill Norrie and a representative for Federal Environment Minister Tom McMillan will officially open the three-day event.

Refreshments will be served.

R.S.V.P. (regrets only)
949-4819

You are invited to bring old and unwanted hazardous household products to the collection depot for free treatment and disposal.

Sponsored by the Manitoba Organizing Committee for Environment Week '86

**YOUR ACTION TODAY — OUR ENVIRONMENT TOMORROW**
**AGISSONS AUJOURD'HUI POUR NOTRE ENVIRONNEMENT DE DEMAIN**

## HOUSEHOLD HAZARDOUS WASTE INVENTORY FORM

Date: ____________________

Time: ______________________

Are all products in original containers? ____Yes ____No
If not, try to determine what is in the container and label properly.

TYPE OF PRODUCT (Specify chemical content if possible) — ESTIMATE QUANTITY OF RESIDUE

1. ____________________________________________
2. ____________________________________________
3. ____________________________________________
4. ____________________________________________
5. ____________________________________________
6. ____________________________________________
7. ____________________________________________
8. ____________________________________________
9. ____________________________________________
10. ____________________________________________

COMMENTS: (e.g. condition of containers) ____________________
____________________________________________
____________________________________________
____________________________________________
____________________________________________

**CONVERSION FACTORS**

1 GAL. = 4 QT. = 4.5 L. = 8 LB. = 4 KG.
1 QT. = 32 OZ. = 1 L. = 2 LB. = 1 KG.
1 PT. = 16 OZ. = 0.5 L. = 1 LB. = 0.5 KG.
1 C. = 8 OZ. = 0.25 L. = 0.5 LB. = 250 G.

## STATISTICAL PERCENTAGES

0003

## HOUSEHOLD HAZARDOUS WASTE

### Survey

1. How did you hear of Household Hazardous Waste Days?

Responses=353

5.2% flyer
21.0% radio
2.5% poster
5.1% friend/word of mouth
19.0% TV
43.2% newspaper ad.
Other 4.0%

Responses=268 2. How many households are represented by this delivery? One=92.5% Two=6.7%

3. Why did you make the special effort to bring your hazardous wastes here?

Responses=374

31.8% Concerned about health effects
60.2% Concerned about environmental effects
Other 8.0%

4. Would you use this service in the future even if: (check all that apply)

| | Yes | No | |
|---|---|---|---|
| Responses=229 | 86.9% | 13.1% | the site was further away? |
| " =235 | 94.9% | 5.1% | the site was open weekends only? |
| " =195 | 74.9% | 25.1% | the site was open during business hours only? |
| " =219 | 95.0% | 5.0% | the service was provided only once/year? |
| " =190 | 63.7% | 36.3% | you had to pay for this service? |

Comments ≈20

5. If this service had not been available what would you have done with your hazardous wastes? (check all that apply)

Responses=316

4.1% flushed down sink or toilet
1.9% put into storm drain in street
39.0% placed into trash can
33.5% would not have disposed
Other 21.5%

It is important to properly dispose of household hazardous wastes, but it is probably more important to consider non-hazardous alternatives.

6. Did you know that there are safer alternatives that can sometimes be substituted for more hazardous products?

Responses=268

52.6% Yes 47.4% No

7. Would you be willing to use less toxic alternatives provided they cost about the same and provided you knew what to buy? 95.8% Yes 4.2% No,
even if these may be slightly more inconvenient to use? 95.8% Yes 4.2% No

Responses=261
" =240

# ONTARIO WASTE MANAGEMENT CORPORATION'S WASTE REDUCTION PROGRAM

KEN C. BRADLEY
MANAGER WASTE REDUCTION
ONTARIO WASTE MANAGEMENT CORPORATION
TORONTO, ONTARIO

Ontario Waste Management Corporation (OWMC) was created in July 1981 for the purpose of building treatment and disposal facilities for Ontario's special wastes. This decision was made following closure of a number of questionable waste management operations and failure of the private sector to provide adequate improved replacement alternatives.

In order to accomplish this task, OWMC developed a plan involving, among other things such as a public participation process, a market assessment process, a site selection process, and a facilities design process.

The market assessment process was comprised of fourteen separate studies which examined the following:

## Market Assessment

Present Waste Quantities, Generation, Types and Distribution
Probable Future Trends
Present Waste Treatment Capability
Legislation and Enforcement Considerations
Potential OWMC Share

A number of interesting conclusions resulted from these studies. For example, we found that about 70% of what we call special wastes (industrial wastes that cannot be adequately treated and disposed of by conventional processes, such as sewage treatment plants, municipal incinerators, and municipal landfills) are generated in the "Golden Horseshoe" area of the province (around the western end of Lake Ontario). We also found the quantities of wastes generated by industries may be arranged in the following order of decreasing amounts:

## Industrial Distribution

Primary Metals
Chemicals
Petroleum
Transportation
Glass, Stone, Clay, etc.
Food and Kindred Products
Paper Products
Leather Products
Fabricated Metal Products
Rubber and Plastics

At about the same time, our facilities design process involving:

Facilities Design

Alternative Technologies
Emission Study
Solidification Study
Preliminary Facility Design

and our site selection process involving:

Site Selection

Selection Criteria
Candidate Sites
Preferred Site(s)
Detailed Site Testing

were activated. All are performed under our policy hierarchy:

Policy Hierarchy

Health
Environmental Impacts
Costs

Now, how does this connect with our program in waste reduction? Here is one way of looking at it. We realize there is a lot of water tied up in many of our special wastes, and a lot of valuable solvents, heavy metals and other useful materials discarded. If at all possible we do not want these materials tying up our costly treatment and disposal resources.

Let's go back a few years. Following World War II we asked industry to give us consumer products and at the cheapest prices. At that time, this process involved throwing wastes into the sewers, burying them, or igniting them. I think we began to realize that the assimilative capacity of the environment was finite some time before we suffered the occasional inconvenience of bridges burning down when a river would ignite from a careless smoker, perhaps, and so we put in place sewage treatment plants, incinerators, and more landfills as well as various regulations, all designed to lessen or reverse the impact of wastes on our environment.

Let's now examine the evolution of one aspect of the traditional industrial disposal process. A manufacturer of organics (including some that are biocides) discharges waste to a newly installed activated sludge sewage treatment plant. Because the activated sludge experiences toxic shock and effluent quality suffers, the generator must lower the "food" to micro-organism ratio by spreading his wastes over more organisms (a modified or bigger treatment plant), or by implementing a waste reduction program. Because of differences in circumstances and perception, it has taken a lot longer for some generators to come to the conclusion that a sound waste management program involving some sort of hierarchy whereby effort is directed first at the source and last at disposal, is the overall least-cost approach.

Either through the economics of waste treatment in that location or by carefully considered foresight, this particular manufacturer implemented just such a waste management philosophy as far back as 1969.

EPA has articulated this in its hierarchy of waste management options first published, I believe, in 1976, and we formally adopted a somewhat similar hierarchy when we articulated our waste reduction program at OWMC in 1984:

### Hierarchy of Waste Management Options

Reduction at Source
Re-use in the process/plant
Recycle to uses outside (Waste Exchange)
Recovery of materials from the waste
Treatment and Disposal

In addition to the earlier loss of certain questionable industrial disposal options, over the last several years Ontario's Ministry of the Environment has phased out the disposal of liquid industrial waste in all but a handful of municipal landfill sites in the province. These and other stringent actions are creating some traumatic experiences for a large number of small companies and marginal industries.

It is, perhaps, appropriate then for some organization to assist industry in its efforts to cope with the many new environmental requirements, many of which have not been gradual nor painless in application. As I said before, because the new generation of treatment and disposal systems are so expensive to site and operate, we want to make sure that nothing is put into them that doesn't belong in them. They will fill up fast enough as it is. That means good, sound technical, regulatory and financial assistance information must be transferred to the many generators who would not otherwise have access to this information.

The following is a list of waste reduction initiatives recently undertaken by OWMC:

OWMC Waste Reduction Initiatives

- Waste Reduction Background Paper
- Waste Reduction Opportunities Study
- Barriers to Reduction, Recycling, Exchange and Recovery
- Hiring of Manager of Waste Reduction
- Funding of Ontario Waste Exchange
- Establishing a Waste Reduction Program
- Hiring of Waste Reduction Technical Representatives

Our final resulting waste reduction program developed in large measure from a study of these initiatives and in particular the "Barriers" report which we had commissioned in 1983. This report described the following four barriers to waste reduction, and I have enlarged on them as you will note in the table below:

Barriers

| | |
|---|---|
| ° Economic | Availability of "Below Cost" Disposal Options (often municipal landfills) |
| | Economies of scale (e.g. small generators can't purchase equipment for the same unit costs as can large generators) |
| | Approval process (time consuming, and time wasted equals missed economic opportunities) |
| | Limited Financial Incentives |
| ° Informational | New Technology (Data on this is not widely circulated) |
| | Financial Assistance (small plants don't have the resources to find out what's available) |
| | Waste Exchange (many plants still know little about this) |
| | Plant Conditions (the proponent of the waste reduction technology often has little understanding of the practical problems caused by conditions in the operating plant) |

| | |
|---|---|
| | Nature of the Waste (Products are fairly well known as pure materials. Wastes are mixtures of many materials and not well characterized because the price on wastes vs. that on products is very low. Information about wastes is therefore sketchy at best) |
| ° Technical | Variable and Complex Nature of Wastes (Wastes aren't easy to characterize because of their complexity. Also, a process waste can vary in nature significantly even when the product causing its generation varies only very slightly) |
| | Equipment Reliability (A minor change in the plant may introduce an unexpected solvent into the waste and the equipment may melt. This is difficult to forecast) |
| | Equipment Capability (Processing equipment has a long history of design for relatively pure materials of high value. Waste is impure, unknown in character and relatively low in value; so it doesn't support much equipment research) |
| | Lack of Appropriate Disposal Systems (Generators may not wish to implement reduction technology where a small concentrated residue results if there is no place within a hundred miles or so to dispose of it) |
| ° Regulatory | Inconsistent Enforcement |
| | Variation in Regulations |
| | Uncertainty re Change (Generators want to know what is expected of them at least over the life of the abatement technology considered) |
| | Regulation by Limiting Concentrations (By reducing volume to precipitate out a pollutant, the remaining materials may exceed allowable concentrations. The incentive then is to expand wastes by addition of a diluent). |

Also, we believe there are a lot of opportunities with waste exchange that are not being acted on. We have, therefore, along with the Ministry of the Environment, funded what we call the Ontario Waste Exchange. The Canadian Waste Materials Exchange is a passive exchange that has been in operation since 1978 and its value has been well recognized. However, there are many wastes listed that we feel represent significant value and should exchange, but for some reason don't. The Ontario Waste Exchange was funded as one of our waste reduction initiatives to investigate these situations to determine what could be done to enable more of these wastes to exchange.

Although our organization was not set up to enable us to impact directly on regulatory, economic, or technical barriers, we did feel we could act directly on the information barrier, and our program which follows reflects this:

## OWMC's Waste Reduction Program

- Promote and Assist the Ontario Waste Exchange
- Search For and Evaluate New Technology
- Search For and Evaluate New Applications for Existing Technologies
- Provide Informational Assistance
- On-Site Problem Assessment
- Waste Characterization
- Promote Sound Waste Management

According to our hierarchy of waste management options, waste reduction technology should arise from a study of the specific industrial process generating the product. Since this focus is highly process specific, the people who can best effect results are those who are closest to it, and these people are employed by industry. If economics and regulations are truly barriers to this process, I believe it is up to the public to become informed, adopt new values and modify the regulatory framework such that the incentives for waste reduction are put in place.

It is my firm belief, then, that "information transfer" is our most effective catalyst for speeding up and directing industry's technical capability towards waste reduction objectives at the pace that the public really is comfortable with.

In our role as information transfer agents we should also not forget to inform legislators and other decision-makers in the public how we believe their current values and regulations are affecting our environment, because these people may also be thought of as sources of waste generation.

Finally, in hopes that we may spark some thinking into new applications of technology for waste reduction objectives, I am including on the next few pages a number of actual Ontario examples which were picked up from personal experience, discussions with others, and some scanning of the literature.

## RECYCLING

Sawdust Converted to Clean Burning Replacement for Coal

- Eliminates Landfilling
- Eliminates Leachate
- Eliminates Fires
- Reduces $SO_2$ Emissions
- Less Coal Mining Wastes

## RECYCLING

Spent Aluminum Chloride Catalyst For Phosphate Removal In A Sewage Treatment Plant

- Eliminates Disposal of Spent Catalyst
- Reduces Wastes Generated By Production of Virgin Phosphate Removal Chemicals

## RECYCLING

Sulfite Waste From A Chemical Plant Used by Waste Treatment Plants To Reduce $CR^{VI}$ To $CR^{III}$

- Eliminates Disposal of Sulfite
- Eliminates Purchase of Virgin Reducing Agent
- Reduces Waste Generated By Production Of Virgin Reducing Agent

## RECYCLING

A Sulphuric Acid Plant's Waste Steam is Now Used By A Chemical Plant

- Less Boiler Feed Water Chemical Wastes
- Less Blow-Down Wastes
- Less Boiler Fuel Used

## RECYCLING

Entropex In Sarnia Converts Plastic Scrap Into New Products

- Reduces Landfill Requirements
- Reduces Virgin Plastic Production Wastes
- Reduces Wastes From Production of Plastics Feedstock Chemicals

## RECYCLING

Sludge From A Forest Products Plant Sold For Use in Paperboard, Experimentally As Soil Condition And As Animal Feed Supplement

- Eliminates Disposal of Sludge
- Reduces Wastes From Production of Virgin Materials in Construction, Soil Conditioning, and Animal Feeds

## HOUSEKEEPING

Storage Tank Wash Water Blended Into Products

- Reduced Wastes
- Reduced Raw Material Usage

## RECYCLING

A Carbon Electrode Producer Sells Waste Carbon Fines For Fuel and Other Manufacturing

- Eliminates Waste Disposal
- Reduces Fuel Production Wastes
- Reduces Virgin Carbon Production Wastes

## RECYCLING

A Sodium Chlorate Manufacturer Sells Waste Hydrogen to a Pulp Mill For Fuel

- Reduces the Quantity of Commercial Fuel
- Reduces Wastes From Production of Commercial Fuel
- Clean-Burning Hydrogen Eliminates Discharge of Pollutants to Atmosphere

## RE-USE

Zenith Plating Employs Counter-Current Rinsing

- Chrome is Returned For Re-Use
- Less Chrome Industry Wastes

## RE-USE

Zenith Plating in Ottawa Rejuvenates Automobile Bumpers

- Reduces Landfill Requirements
- Reduces Steel Industry Wastes

## RECYCLING

Re-Refiners Convert Used Oils Into New For Re-Use in Industry

- Eliminates Disposal of Waste Oils
- Reduces Waste From Production of Virgin Oil

### PROCESS CHANGE

Direct Steam Injection Replaced With Indirect Heating in a Solvent Recovery Still

- Reduced Volume of Waste Still Bottoms
- Down-Sized the Waste Treatment System
- Less Treatment Plant Fuel Needed

### PROCESS CHANGE

Ion Beam Etching in Place of Acid in Printed Circuit Manufacturing

- Eliminates Copper Sulphate Wastes

### RAW MATERIAL SUBSTITUTION

Boiler Plant Conversion From Bunker C to Natural Gas

- Eliminates Sulfur Dioxide Emissions
- Eliminates Fly Ash
- Eliminates Soot

### PROCESS CHANGE

A Chemical Company With a Salty Caustic Aqueous/ Organic Waste Installed an Evaporator

- A Large Waste Stream Converted to a Smaller Solid Waste
- Caustic Concentrated for Sale
- Less Wastes From Production of Caustic
- Less Wastes From Production of Neutralizing Acids

### PROCESS CHANGE

A Chemical Company Installed Caustic Scrubbers For Chlorine Tank Evacuation Gas

- Spent Scrubber Solution Sold
- Eliminated Disposal
- Reduced Bleach Industry Wastes

### PROCESS CHANGE

Powder Painting in Place of Spray or Dip-Painting

- Reduction in Paint Wasted
- Less Paint Purchased
- Less Paint Industry Waste
- Less Pigment, Solvent, and Resin Industry Wastes

## RECOVERY

A Steel Plant Uses Centrifuges to Recover Oil from Waste Water

- Reduces Purchased Oils
- Virgin Oil Production Wastes Reduced
- Eliminates Oil From Steel Plant Wastes

## RECOVERY

A Paper Company Recovers Oil From Waste Water and Adds it To Sawdust For Use as Fuel

- Recovers Energy From Both Sawdust and Oil
- Reduces Waste From Production of Virgin Fuel

## RECYCLING

Whey Waste From a Cheese Plant Recycled Into Animal Feed

- Eliminates Disposal of Whey
- Reduces Traditional Animal Food Protein Wastes (Fertilizer Production Wastes, Herbicide Wastes, Farm Run-Off Wastes)

# PACE WASTE MANAGEMENT GUIDELINES FOR PETROLEUM REFINERIES AND UPGRADERS-AN INDUSTRIAL CODE OF GOOD PRACTICE

Peter Budzik and Associates Ltd.

Peter Budzik

Paper unavailable at time of printing

# IS A METAL SLUDGE A 433? a SCHEDULE IV? A NA9307?...

Ontario Waste Management Corporation

A.E. Veel

Paper unavailable at time of printing

# FOUNDRY BAGHOUSE DUSTS
# WASTE CHARACTERIZATION

E. Callin and S. Manning
Norwest Labs, Edmonton

A. J. Leander
Alberta Environment,Pollution Control Division
Waste Management Branch

G. Klassen
Chem-Security Ltd., Edmonton

## INTRODUCTION

This study was undertaken to determine whether foundry baghouse dusts should in general be classified as a hazardous waste and if not, whether any foundry waste types are hazardous.

Interest in characterizing waste products generated in Alberta has essentially been non-existant prior to this year. The passage of Alberta Environment, Hazardous Waste Regulation 49/85 in the spring of 1985, has placed the responsibility on the generator to determine whether wastes are non-hazardous and suitable for landfill disposal. Wastes which are hazardous will require treatment to render them non-hazardous by the operator himself or be sent for disposal at an approved facility such as the one presently being constructed at Swan Hills. It is required that a generator classify his own waste materials.

The 1960s and 1970s saw a development of environmental regulations basically aimed at limiting water and air pollution. This had the effect in the foundry industry of establishing particulate and gaseous emission standards in an attempt to limit air pollution. In 1974, the Federal Government surveyed the foundry industry with respect to establishing national emission guidelines. Subsequently, in 1979, the Federal Government prepared a technical review[1] of the foundry industry which outlined the basics of the industry, as well as the technology available to the industry to control emissions. While this report deals with how air pollution can be controlled, it does not deal with how the resulting solid wastes can be dealt with. For the most part, dusts collected in fabric filters, cyclones, rotoclones, baghouses, or other air pollution control devices, have been handled as refuse, and have been dumped at sanitary landfills or used as fill for low areas.

These disposal practices are a concern because of related wastes generated from iron and steel plants which are designated or defined as hazardous wastes. The Transportation of Dangerous Goods Regulation[2] has categorized "emission control dust/sludge from the primary production of steel in electric furnaces", as Waste Type 80, a hazardous waste. Moreover, similar dust in the United States has been classed by the Environmental Protection Agency, (EPA) as a hazardous waste (U.S. Federal Register[3]).

As part of the Industrial Monitoring Program of the Waste Management Branch of Alberta Environment, samples from a few foundries were taken in 1984, to determine whether a potential problem existed in Alberta. Analysis of these samples indicated that some foundry waste streams were potentially hazardous while others were not.

The preliminary information obtained in 1984 led to the undertaking of this study with the hope of being able to classify the various foundry wastes. In this regard, fifteen operations in the Province of Alberta were contacted and arrangements were made to obtain samples from their waste streams.

The study was to concentrate predominately on dusts given off by the furnaces of the various foundries. However, it was felt that it was appropriate to sample other foundry waste streams as well for the following reasons:

1. Foundries combine their waste streams for disposal, and may even use the same collection device to collect different wastes.
2. Other studies[4] have noted that foundry casting sands are contaminated with trace metals and phenols.

The amount of wastes generated by the foundry industry is directly proportional to the capacity of the operations. The average foundry in Alberta has the capability to melt just over 3 tonnes of metal per hour. However at the time of survey no foundry was operating at capacity because of an economic slow down in the Province. Approximately 8,500 tonnes of baghouse dust, waste sand and slag are generated in Alberta on an annual basis. This excludes the primary iron and steel industry which can generate approximately 37,000 tonnes of slag and baghouse dust per year. Approximately twenty-five percent of wastes generated by the primary iron and steel industry is classified as being hazardous.

Characterization of the materials being disposed of by foundries was made by performing laboratory analysis of grab samples. Analyses were made to measure the total concentration present as well as its potential for release of constituents to the environment.

Laboratory methods have been developed to simulate the leaching effect that a waste material would undergo in a landfill site. Waste samples are mixed with an aqueous solution under controlled laboratory condition to prepare a leachate. The concentration of constituents in the leachate is analyzed to determine whether or not the waste material is hazardous and suitable for landfilling.

Over the past several years, the E.P.A. has evaluated several laboratory leach tests. One of the initial methods developed and published in a procedure manual, "Test Methods for Evaluation of Solid Waste Physical/Chemical Methods"[5], was called the Extraction Procedure (EP) Leach Test. The method involved agitating the waste material with a dilute acetic acid solution (pH 5.0). The EP was a time consuming analysis and has been most recently replaced with the Toxicity Characteristic Leaching Procedure (TCLP). This procedure is similar to the EP but requires less operator attention and thus is a less expensive laboratory analysis. The precision of the analysis was also found to be much improved. The TCLP was used in this study. Although Alberta Environment and most other provinces in Canada still have the EP method listed in their regulations the TCLP was chosen in anticipation that Canadian provinces would also follow the TCLP method in the near future. To date this has not happened.

Although the determination of metals present was the major emphasis of this study, analysis for organics, specifically phenols, was also included for selected samples. Organics originate from binders used in the molds for casting metals. Previous studies [6,7,8,9,10,11] concentrated on the carcinogenic effects of workers exposed to airborne organics. No information was available to determine whether the organics present would be sufficiently high enough to pose an environmental hazard. One sample was also selected for more intensive analysis by gas chromatography/mass spectrometry to identify the specific organics.

## EXPERIMENTAL METHODS

### Sample Site Selection

Fifteen operations in the Province of Alberta were contacted and arrangements were made to obtain samples from their waste streams. The operations inspected consisted of foundries involved in producing grey iron, specialty irons, steel, brass, bronze and aluminum castings, as well as operations specializing in the finishing of foundry castings and non-integrated iron and steel producers. These operations ranged in age from the early 1900's to less than five years old. Thus, the technology employed by the operations surveyed varied from gas fired melting crucibles, to cupolas, induction furnaces and electric arc furnaces. Although baghouses were the primary air emission control devices used in the operations surveyed rotoclones and multicyclones were also encountered. The age and the technology of the baghouses ranged widely. Moreover, while some companies used a number of baghouses to collect individual waste streams, others used one or two to collect a combination of waste streams.

The fifteen operations were examined and divided into various grouping within the metal industry based on the type of raw material used, method of melting and the products produced. Thus seven major smelting categories were defined. In addition, one metal finishing operation producing large volumes of metallic dust was examined for comparison. The following is a brief explanation of the industry types and the companies involved.

Decorative Metal - Companies A, B, K
- small foundries which melt aluminum, brass or bronze in fuel fired pot furnaces to produce plaques, monuments, special tools or fittings, etc.

Specialty Iron Cupola - Company D
- foundries which produce grey iron casts, as well as ductile or Ni-hard iron in a cupola. Pig iron is utilized almost exclusively for ductile and Ni-hard casts. Heat for melting is supplied by coke added to the cupola. Limestone is usually added to remove impurities.

Iron Induction - Company C
- foundries which utilize an electric induction furnace to melt scrap cast iron to produce grey iron casts.

Steel Electric Arc - Companies F, O, P*
- foundries or primary iron or steel industries which produce steel casts or iron or steel products by melting scrap steel in an electric arc furnace where the energy is supplied by three graphite electrodes in the melt.

Steel Induction - Companies L, H
- foundries which produce steel casts by melting scrap steel in an electric induction furnace.

Specialty Iron Induction - Companies G, J
- foundries which, besides producing grey iron casts, produce ductile and or Ni-hard iron in electric induction furnaces.

Iron Cupola - Companies M, N, I
- foundries which utilize a cupola fired with coke to melt scrap cast iron to produce grey iron casts.

Finishing - Company E
- operation where metal is finished using grinding and shot blast operations.

---

* Company P was not included in this study. The company had been sampled previously, and it was decided not to re-do the sampling. The volumes of wastes are not included in the totals but are included to given an overall volume of wastes generated in Alberta.

## Sampling Procedure

Due to the various types of technology, ages and layout of the operations and the use of different air emission equipment to collect waste streams, collection of similar samples from all operations was impossible. Where possible, all surveyed operations were visited twice in 1985. At the time of the visit, grab samples were taken from collection hoppers. Some operations, however, had all their emission control devices discharge into one bin and in these cases, a sample was collected at the discharge point. In one or two circumstances, it was impossible to obtain samples from a hopper because it had just been emptied. In these circumstances, no samples was taken or a sample was obtained from material spilled on the ground when the hopper had been loaded or unloaded. This was only done where the hopper received one specific waste stream.

Two operations were requested to undertake a more regular sampling program of their dust collection systems. The companies were requested to take grab samples every other day if they were operating. This resulted in approximately twelve samples being taken over a one month period at each operation.

In total, 102 grab samples were obtained for analyses. The samples are predominantly from baghouses which collected emissions from the furnaces, grinding operations pouring areas, sand systems, shotblast operations, shakeouts and wheelabrators. In addition, samples of casting sands, slag, floor sweepings, rotoclones, multicyclones and residues from sand blasting operations were also taken. A 500 ml. jar of each sample was taken. The majority of samples consisted of a fine dust, but other samples ranged from a wet sludge to a solid matrix (i.e., slag).

## Sample Splitting and Handling

All samples were taken in 500 ml. glass jars with teflon seals. The samples were collected in the course of a field trip were brought to the office where sample numbers were recorded. The samples were then delivered to the lab. There were four samples split to provide blind duplicates. These four samples were first screened (40 mesh) to remove large particles. Then the samples were split using two passes through a riffler. These samples were then segregated and delivered to the lab in separate batches on separate days.

## EXPERIMENTAL DESIGN

### Summary

All samples were characterized for total metals present by performing a strong acid digestion with nitric/perchloric/hydrofluoric acids. This represented the maximum potential leachable metal present. Approximately 70% of the solid samples were also extracted with buffer solutions using the TCLP extraction procedure leach test to determine the extractable metals present. Both the total digest solutions and the TCLP leach solutions were analyzed by a combination of ICP spectroscopy and atomic absorption spectroscopy (AAS). The ICP analysis was performed by Quanta Trace Labs, Vancouver. Approximately 20% of the solid samples were analyzed for total phenolics using the Standard Methods 4AAP colorimetric analysis. One of the samples identified as having phenolics present was further analyzed by computerized gas chromatography/mass spectrometry (by Enviro-Test Labs) to charactize the phenolics and organics present.

### Procedure

Total Metal Analysis

The total metal analysis was performed to determine the total potential metal present. Thus, a digestion procedure was selected that would ensure a complete breakdown of the sample matrix without a loss of any metals.

A nitric/perchloric acid digestion was performed to dissolve most of the metals not tied up in the silicate matrix and ensure that volatile elements would be retained in solution. The insoluble material was then digested with nitric/perchloric/hydrofluoric acid to release metals tied up in the silicate matrix. This digestion procedure resulted in dissolution of greater than 98% of the sample. All samples were analyzed by ICP Spectrometry. Analysis for arsenic, selenium and mercury was performed by flameless atomic absorption spectrophotmetry.

### Leachate Metal Sample Analysis

The Leachate analysis, referred to as the Toxicity Characteristic Leaching Procedure (T.C.L.P), is designed to simulate the leaching a waste will undergo if disposed of in a sanitary landfill. The TCLP procedure used is described in detail in the U.S. Federal Register[3]. The solid sample was extracted with an extraction fluid equal to 20 times the weight of the solid phase. The extraction fluid used (either pH3 or pH5) was selected based on the alkalinity of the solid sample.

The extraction was performed by mixing the solid sample with a volume equal to 20 times the solid weight and rotating in the extractor vessel at 30 rpm for 18 hours.

After the 18 hours extraction, the sample was filtered and preserved with acid.

### Quality Control

Both accuracy and precision of the analyses was measured. Every tenth sample was analyzed in duplicate to measure instrumental precision. As well four blind duplicates were also inserted. Accuracy was monitored by digesting and analyzing two NBS samples (a fly ash and a slag) and an EPA municipal sludge. Two samples of digest and two leachates were also sent to another laboratory (Alberta Environmental Centre) for ICP analysis.

## DISCUSSION

Precision of analysis was performed by comparing lab duplicates and blind duplicates. As the constituent levels varied significantly depending on the foundry type the duplicate data was evaluated by normalizing the data (i.e., comparing the difference in a set of duplicate over the sum).

A normalized number of less than .1000 indicated an average difference of less than 20% difference in the data. A normalized number of greater than .2000 indicated a difference of greater than 50%. Good precision of analysis was achieved for the lab duplicate analysis. Only those analyses close to the detection limits showed variations of greater than 10%.

The precision of the four blind duplicates showed greater variability but was still very good at the higher concentrations. At the detection limits the precision was poor. Analysis for silicon was also not good for the total analysis. Although the average of the data showed good precision there were some differences on some duplicates on some constituents (specifically copper and zinc) that showed differences of greater than 50%.

We have observed in other studies on comparing ICP data, the precision of ICP analysis at the higher concentrations is good but at low concentrations as the detection limit is approached, precision is poor. This is particularly true for total acid digests where solution matrix interferences will affect detection limits.

Accuracy. The accuracy was measured by analyzing standard reference material and by comparing analyses of another laboratory.

Recoveries for the EPA sludge was very good (usually better than 95%) for all constituents. The NBS flyash and slag reference samples, which were more difficult to digest, showed recoveries of 90% for all constituents except aluminum and silicon.

The analysis between two labs compared well. Again analysis close to detection limits did not compare well. One set of analyses for iron on a sample that was 50% iron did not compare well.

ICP is the most cost effective method for screening for a large number of metals. It is not the most precise or accurate method of analysis for any constituent unless the ICP system is specifically optimized for that element.

## Generation of Hazardous Wastes

Under the existing Hazardous Waste Regulation in Alberta, a solid waste is a hazardous waste if a leachate exceeds certain concentrations. Table 1 outlines which industry wastes are a hazardous waste as well as the metal or metals which cause the waste to be hazardous.

The table also indicates the number of wastes streams at each operation for which a leachate analysis was done. The total waste streams analyzed is 40. Of these 16 waste streams were hazardous. It should be noted that if Zn is removed from the leachate test (as proposed in the amendments to the Federal T.D.G. Regulations) then only 8 out of the 40 waste streams are hazardous. It should be noted that the Federal Transportation of Dangerous Goods Regulations lists waste Type 80 (Emission Control Dust/sludge from the primary production of steel in electric furnaces) as a "fully specified" hazardous wastes. Thus by definition STEEL ELA comprising companies F, O and P are hazardous wastes. Thus out of a total of 12,018 tonnes per year produced, in essence, all of it is potentially hazardous since at least 1 waste stream comprising each of the sub-totals is hazardous. If Zinc is excluded then 6666 tonnes or about 79% is hazardous. If the Alberta total is used and Companies F, O, and P and considered to be hazardous by definition the 10,786 tonnes or 90% are hazardous.

## Volumes of Wastes Generated

During the course of this study it became abundantly clear that the various foundary operations had in general little or not knowledge of the amount of wastes produced. The operators could give an approximate volume of wastes removed (i.e., "truckload a month", or "three bins a week") but had no idea of the mass of wastes produced.

In order to assist in quantifying the wastes produced a bulk density was taken on representative samples.

Table 2 gives the volumes of wastes produced by the companies and calculates the mass of waste for each industrial type.

## Changes with Time

As part of the study the changes in the composition of the baghouse dust with time was addressed. First of all in the short term two companies C and O agreed to take samples over approximately a one month interval, 2 to 3 days between samples. For the long term 2 samples were taken at each company (at identical sampling locations where possible) at a 6 to 8 month interval.

Over the short term, it was remarkable how consistent the results were. Both the total and leachate analysis showed consistence from the beginning to end.

## TABLE 1
## GENERATION OF HAZARDOUS WASTES

| Industry Type | Company | # of Waste Streams Sampled | # of Hazardous Waste Streams Sampled | Hazardous Waste | Metals which make Waste Hazardous |
|---|---|---|---|---|---|
| Decorative Metals | A | 1 | 1 | BAG SH BL | Zn |
| | B | 2 | 2 | BAG Gr | Pb, Zn |
| | | | | CA SA | Pb, Zn |
| | K | 2 | 2 | SA BL | Cu, Pb |
| | | | | FL SW | Zn |
| Specialty Iron | D | 2 | 0 | | |
| Iron Induction | C | 5 | 2 | BAG FUR | Cd, Pb, Zn |
| | | | | BAG PR/SA | Pb, Zn |
| Steel Electric Arc | F | 3 | 1 | BAG FUR | Zn |
| | O | 1 | 1 | BAG FUR | Cd, Pb, Zn |
| | P | | | | |
| Steel Induction | L | 2 | 0 | | |
| | H | 3 | 1 | BAG GR/PR | Zn |
| Specialty Iron Induction | G | 5 | 1 | BAG FUR | Zn |
| | J | 2 | 1 | BAG PR/SA | Zn |
| Iron Cupola | M | 2 | 1 | BAG FUR | Cd,Pb,Zn |
| | N | 3 | 1 | MULCYC | Zn |
| | I | 3 | 1 | MULCYC | Zn |
| Finishing | E | 4 | 1 | BAG ARWE | Cu |
| TOTAL | | 40 | 16 | | |

## TABLE 2

## WASTE PRODUCTION

| Industry Type | Company | Sample Type | Density gm/ml | Mass of Wastes tonnes/yr |
|---|---|---|---|---|
| Decorative Metals | A | BAG SH BL | 1.8414 | — |
| | B | BAG GR | 1.7025 | 2 |
| | | BAG GR | 1.5729 | |
| | | CA SA | 1.1712 | |
| | K | SA BL | 1.6005 | 6 |
| | | SA BL | 1.4058 | |
| | | FL SW | 1.7398 | |
| Specialty Iron Cupola | D | | | 26 |
| Iron Induction | C | BAG FUR | 0.6643 | 34 |
| | | BAG FUR | 0.6767 | |
| | | BAG PR/SA | 1.2368 | |
| | | BAG PR/SA | 0.7099 | |
| | | BAG SH BL | 1.2108 | |
| Steel Electric Arc | F | BAG FUR | 1.1833 | 520 |
| | | BAG FUR | 0.9870 | |
| | | BAG SA | 0.9143 | |
| | | BAG WH | 1.7043 | |
| | O | BAG FUR | 0.8836 | 6570 |
| | | BAG FUR | 0.8138 | |
| | | BAG FUR | 0.7057 | |
| | P | Not included in sampling program | | (3600)* |
| Steel Induction | L | BAG FUR | 0.9431 | 22 |
| | | BAG SA | 1.6963 | |
| | H | BAG WH/SA | 1.6479 | 174 |
| | | BAG GR/PR | 2.0760 | |
| Specialty Iron | G | BAG SH/GR | 1.3418 | 248 |
| | | BAG WH | 1.1761 | |
| | | BAG SA | 1.6546 | |
| | | BAG FUR | 0.7320 | |
| | J | BAG WH | 1.5107 | 535 |
| | | BAG PR/SA | 0.7761 | |
| Iron Cupola | M | BAG FUR | 0.4137 | 25 |
| | | BAG PR/SA | 1.3921 | |
| | | BAG PR/SA | 1.1172 | |
| | N | BAG SH BL | 1.5579 | 158 |
| | | MULCYC | 1.1124 | |
| | | BAG WH | 1.1828 | |
| | I | BAG WH | 1.6233 | 69 |
| | | MULCYC | 1.1306 | |
| Finishing | E | BAG AR WL | 0.6427 | 29 |
| | | BAG WH | 2.2754 | |
| | | BAG WH | 2.2208 | |
| | | BAG WH | 2.3033 | |
| | | BAG SH BL | 3.1540 | |
| | | FL SW | 1.2383 | |
| | | | | 8418 TOTAL |

*Not included in study
Presented to give a value for total volumes generated in Alberta

(12018 Alberta Total)

Concentrations for Cd, Cu, Pb and Zn in both the totals and the leachates did not vary significantly more than 25% from the average.

Over the long term there was little consistency. Depending on the industry and the sample location concentrations of both total and leachates varied 100 fold or more.

### Leachable Metals

Calculations were also made by comparing leachate concentrations to total concentrations to total concentrations to determine the percent of metal extracted from a solid sample by the TCLP method. Cadmium and zinc were very easily extracted (up to 70% Cd). Other toxic metals found in the total analysis including chromium were essentially not extractable.

### Organics

Of the 20 samples selected for total phenol analysis 5 samples had phenol concentrations that ranged between 72 ppm and 156 ppm. The balance of the samples contained less than 5 ppm phenolics.

The sample that contained 140 ppm phenol was analyzed by GC/MS. Although the major constituent was found to be phenol 2 ppm of 2,4 dimethyle phenol was detected. No nitro-phenols were detected.

Of the PAHs only traces of naphthalene and phenanthrene (less than 1 ppm) were detected.

The previous study found that the organics present were produced as a result of the binders used in the molds. The present of PAHs present in this study may be as a result of the breakdown of the raw material (scrap metal) used. Insufficient data was collected to determine the level of any toxic organics present.

## CONCLUSIONS

1. Using the TCLP extraction procedure and applying present Alberta Environment Hazardous Waste Regulations baghouse dusts are a hazardous waste. Many of the leachates had concentration levels of cadmium, copper, lead and/or zinc that exceeded the Regulations limits. Separation of the waste streams would significantly reduce the volume of hazardous waste.
2. Due to the variability of some foundry dust types, single grab samples should not be used to classify a waste stream.
3. The TCLP leachate preparation method is not labor intensive and combined with analysis by ICP spectrophotometry are relatively inexpensive methods for evaluating inorganics in a waste stream. Regulations are required that define analytical methods for classifying wastes. A total characterization may not be required for many wastes.
4. A cursory look at organics in foundry dusts indicates that further work may be required to determine if hazardous levels exist.
5. If generators of waste products were more knowledgeable of the volume and type of waste produced they would probably be able to significantly reduce the hazardous amount.

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# STUDY OF PERCHLOROETHYLENE STILL-BOTTOM RESIDUE WASTE ASSOCIATED WITH THE ALBERTA DRY CLEANING INDUSTRY

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# RURAL SOLID WASTE TRANSFER - THE FLAGSTAFF EXPERIENCE

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# CONSIDERATION OF CLAY SOIL AND LEACHATE INTERACTIONS IN LANDFILL LINER DESIGN

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## ABSTRACT

Alternative test procedures are described which take into account major limitations in the current landfill clay liner design practice which is based upon the standard permeability test. The main weakness of current procedures is their inability to account for the leachate constituent and clay soil interactions and resulting consequences. In situations where soil shrinkage occurs as a result of clay-leachate interactions, measures should be taken to minimize the shrinkage potential while providing additional liner thickness to account for shrinkage cracks.

## BACKGROUND

A sanitary landfill, located, designed and operated to minimize environmental impact, may pose a potential threat to ground and surface waters if "leachate", the contaminated water containing inorganic and organic compounds produced during the various physical, chemical and biological processes occurring within the landfill, is allowed to escape freely from the disposal site. Recently, sanitary landfill designs have often incorporated an artificial barrier to restrict the escape of leachate. Many materials have been proposed and used as barriers in landfills, but the most popular type is a clay soil liner.

In designing a clay liner for a sanitary landfill, both pollutant attenuation and containment capabilities of the liner need to be considered. However, the primary objective of current clay liner design practice is to minimize its bulk permeability. The design procedure calls for evaluation of the selected soil in the laboratory to determine the influence of compaction upon the hydraulic conductivity, k, (previously termed the coefficient of permeability) of the soil. In general, the standard permeability test procedure is adopted using distilled water or 0.01N $CaSO_4$ as the permeating liquid. Generally, the hydraulic conductivity (k) should be less than $10^{-9}$ m/sec, at field density, for the soil to be selected for liner construction. If the available natural clay soil does not achieve this low value, after compaction, commercially available bentonite (Na-montmorillonite) may be added (Fuller and Warrick, 1984).

Numerous studies have demonstrated deficiencies in an approach based solely on hydraulic conductivity. The k values obtained from standard permeability tests are known to under-estimate the field values by factors of 10 to 10,000 (Dunn and Mitchell, 1984). The greater field values result from the presence of cracks, fissures and slickensides (Daniel, 1984), improper construction practices (Mundell, 1985), problems associated with the standard laboratory permeability testing procedure (Olson and Daniel, 1981, Dunn and Mitchell, 1984) and the possible interactions between clay soil and leachate constituents (Hettiaratchi et al., 1987).

Although soil is considered an inert material under normal conditions, organic and inorganic compounds present in landfill leachates have the capability to interact with clay particles in the soil. The net result can be a change in the geotechnical properties of the clay soil. A possible consequence of the clay soil and leachate interaction is the volumetric shrinkage of the soil resulting from changes in interparticle physico-chemical forces within the clay soil. In the field, such shrinkage would ultimately produce shrinkage cracks which promote increased bulk permeability across the compacted clay liner. The standard direct permeability test, with its small soil specimen, is not capable of demonstrating such consequences in the laboratory. Furthermore, neither distilled water nor 0.01N $CaSO_4$ represent the leachates expected in the field.

This paper introduces test procedures which take account of the major limitations in the common design procedures based upon the standard permeability test which is not designed to account for volume shrinkage of the soil. Because shrinkage cracks are a major cause of high permeability, it is necessary to monitor the ability of a leachate to cause "synaerisis shrinkage" (the shrinkage caused by the changes in interparticle physico-chemical forces within the soil system). The Synaerisis Shrinkage Test procedure discussed in this paper allows monitoring of shrinkage and as well providing an approximate k value to be used in subsequent design. The Sedimentation Test procedure is a simple, rapid test which can be used to identify soil materials susceptible to shrinkage during interaction with leachates.

## ALTERNATIVE LINER EVALUATION PROCEDURE

Volume shrinkage is a major contributor to increased permeability across clay liners. The standard permeability test fails to account for the interaction between the clay soil and the components of the liquid being tested. If the test is performed in a fixed wall permeameter with little or no surcharge pressure acting on the soil sample, a liquid containing high concentrations of organic or inorganic compounds would "breakthrough", because of the creation of macropores by lateral shrinkage of the soil (Ridley, 1985). If a higher surcharge pressure is applied and/or a flexible wall permeameter is used to minimize lateral shrinkage, such breakthrough could be avoided. However in the latter case, closure of pores during shrinkage causes a lower value of k to be measured. Because of the inaccurate k value determined in such a test, supplementary data may be needed to properly estimate valid field values for k.

The soil testing techniques described here provide information on the synaerisis shrinkage and permeability behavior of the soil. They offer a viable alternative to the standard permeability test approach.

### Synaerisis Shrinkage Test

This test simulates the behavior of a clay liner under exposure to leachates and is used to generate both synaerisis shrinkage and permeability parameters for a given soil-liquid combination. The test is performed in a specially constructed consolidometer. The details of apparatus construction and the test procedure are presented in Hettiaratchi et al., (1986). The salient features of the test apparatus and test procedure include: corrosion-resistant construction, the ability to test fully saturated, artificially sedimented (more parallel plate orientations) soil samples and the possibility of direct permeability measurements if needed. The synaerisis shrinkage is measured directly as PERCENT STRAIN (shrinkage/initial soil thickness, %) and a computational technique using pre- and post-leachate consolidation results is used to obtain the k values.

**Synaerisis Shrinkage Caused by Leachates** A typical void ratio versus effective stress curve obtained during a synaerisis shrinkage test is shown in Figure 1. The chemical composition of the pore water in the soil sample was altered, with the introduction of simulated municipal solid waste (MSW) leachate into the system, at point $A_2$. The resulting synaerisis shrinkage, is shown by the $A_2A_3$ portion of the curve. Details of the characteristics of the leachate and the soil used in this experiment are provided in Hettiaratchi et al., (1987).

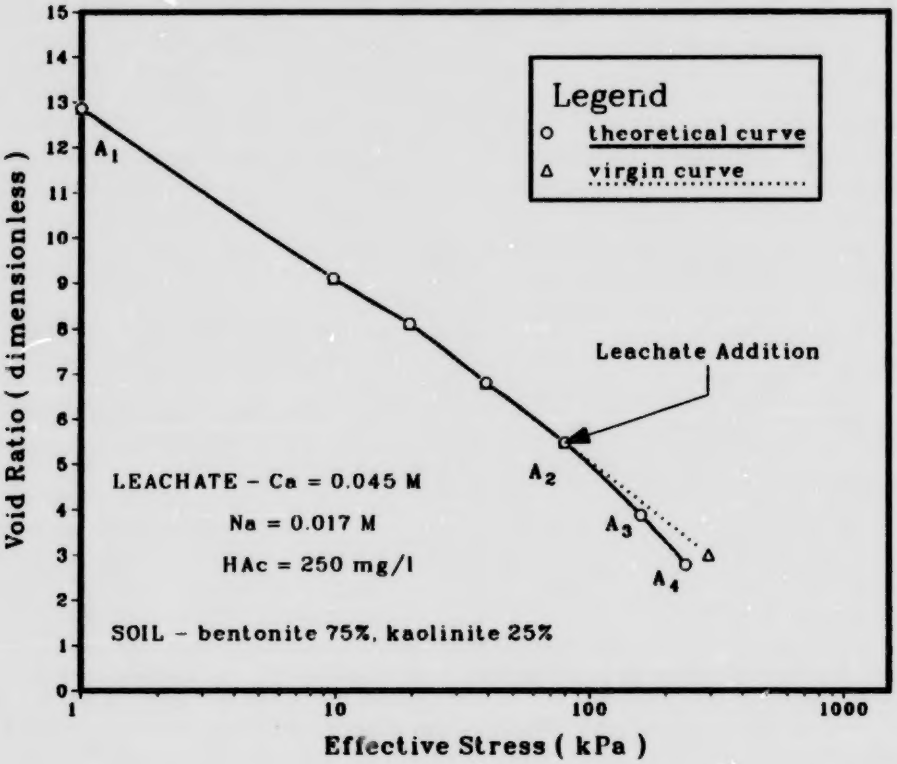

FIGURE 1 TYPICAL SYNAERIS SHRINKAGE TEST RESULTS
(shrinkage from A2 to A3 caused solely by leachate)

The addition of leachate, caused double layers surrounding the clay particles to be compressed, resulting in a release of interparticle repulsive stresses and an increase in the effective stresses within the system (Hettiaratchi et al., 1987). The increase in effective stress and the subsequent volume shrinkage in a soil maintained at a constant surcharge pressure of 80 kPa (equal to the surcharge at the bottom of a 10 m deep MSW landfill) are found to be functions of type and amount of clay minerals in the soil, type and concentration of cations in the interacting liquid (Hettiaratchi et al., 1987). Greatest shrinkages were observed with soils containing high percentages of Na-montmorillonite and with leachates containing higher concentrations of $Ca^{+2}$ ion. Soils high in kaolinite and Ca-montmorillonite (another low-swelling clay mineral) did not show significant shrinkages even with high $Ca^{+2}$ concentrations.

**Effect of Leachate Constituents on k** Consolidation results provide a means of indirect determination of hydraulic conductivity (k) of a soil. The values reported in Table 1 were obtained by applying the Terzaghi's theory of consolidation to the pre- and post-leachate time-settlement observations.

TABLE 1. EFFECT OF $Ca^{+2}$ CONCENTRATION IN LEACHATE ON HYDRAULIC CONDUCTIVITY (k)

| Soil Sample Number | $Ca^{++}$ concentration in leachate (mg/l) | post-leachate k ($m/s \times 10^{-10}$) | Void Ratio pre-leachate | Void Ratio post-leachate |
|---|---|---|---|---|
| 1 | - | 1.87 | 2.94 | 2.91 |
| 2 | 0.002 | 1.61 | 2.80 | 2.75 |
| 3 | 0.004 | 1.97 | 2.78 | 2.73 |
| 4 | 0.009 | 1.95 | 2.85 | 2.73 |
| 5 | 0.016 | 2.12 | 2.86 | 2.57 |
| 6 | 0.022 | 2.60 | 2.79 | 2.37 |
| 7 | 0.045 | 3.15 | 2.84 | 2.32 |
| 8 | 0.090 | 3.74 | 2.83 | 2.24 |

These results indicate that k increased while the void ratio decreased (as the synaerisis shrinkage increased) with increasing $Ca^{+2}$ concentration. But, the overall effect of the change in k is less than an order of magnitude. Such a "small" increase in k is not of major concern to the design engineer. Effectively it is negligible, when compared with the possible large increases in field bulk permeability, which can arise from shrinkage and crack formation. For example, the soil 8 (Table 1) showed a 21% reduction in void ratio, indicating a very high potential for crack formation, but showed only 0.2 orders of magnitude change in k, during permeation with a liquid containing a high $Ca^{+2}$ (= 0.09 M) concentration.

A question may be raised about how well the k values calculated using this method compare with values obtained by direct permeability testing. Mesri and Olson (1971) contended that the calculated k values generally underpredict measured values, but by only 5-20 percent, provided that the soil sample is normally consolidated.

## Sedimentation Test Results

The soil liquid parameter, PERCENT STRAIN, could be directly related to the field situation. However, several weeks may be necessary to generate the PERCENT STRAIN value for a given soil/liquid combination. The need to expose a liner material to a vast array of inorganic and organic compounds requires that a simple test be available to study the interaction of the soil with various liquid combinations.

Although the behavior of a sedimenting soil is not strictly comparable with a compacted soil, the sedimentation test provides information on the interparticle stresses and the flocculation behavior of soil-liquid systems (Hettiaratchi et al., 1986). The sedimentation test is a modification of the "free swell test" originally proposed by Holtz and Gibbs (1956) to identify swelling soils. Our test involves sedimenting a known mass (10 g) of clay soil (passing the #200 sieve) in a 100 ml graduated cylinder filled with the test liquid. The resulting equilibrium sediment volume ($V_\ell$) when compared with the equilibrium sediment volume in de-ionized distilled water ($V_d$) indicates the swelling/shrinking behavior of the soil in the presence of the test liquid.

As in the case of synaerisis shrinkage, the process of sedimentation (floc formation and particle settling) is controlled by the interparticle physico-chemical forces. The equilibrium sediment volume in a given liquid ($V_\ell$) is indicative of the magnitude of the net interparticle repulsive stress created between interacting clay particles. Higher swelling soils sediment to larger volumes ($V_d$) in deionized water. The presence of electrolytes at higher concentrations in test liquids tends to reduce the thickness of the double layer and results in lower $V_\ell$ values.

Since sedimentation in an electrolyte environment and synaerisis shrinkage both are subjected to the same phenomenon it was possible to develop a regression equation relating the synaerisis shrinkage parameter, PERCENT STRAIN, to the corresponding parameter developed from sedimentation results, FSD (Hettiaratchi et al., 1986), where FSD is given by:

$FSD = ((V_d - V_\ell)/V_d) \times 100$
$V_d$ = equilibrium sediment volume in deionized water, ml
$V_\ell$ = equilibrium sediment volume in test liquid, ml

The relationship indicated that high PERCENT STRAIN values should be expected if the FSD value obtained from a simple sedimentation test is high. Such a relationship could be used to estimate the corresponding PERCENT STRAIN if the FSD value is known for a given soil leachate system.

**Sedimentation of Soils in Organic Contaminants** Performance of a long term synaerisis shrinkage test would be more difficult with hazardous organic contaminants. However, some indication of their shrinkage capability could be assessed by performing a sedimentation test.

Some FSD values obtained for soils rich in clay mineral montmorillonite in aqueous solutions of acetone, glycerol, dioxane, ethylenediamine, ethanolamine and urea are presented in Hettiaratchi and Hrudey (1987). Contrary to the findings of others (Green et al., 1983) for un-diluted organic chemicals, shrinkage behavior does not always correlate well with the static dielectric constant of a leachate. The presence of water greatly affects the clay-organic interaction. For example, although 100% acetone and methanol are capable of shrinking a clay soil excessively, at low organic fractions (less than 20%) rather than shrinking the soil, the organic-water mixture tends to swell the soil (Hettiaratchi and Hrudey, 1987). Because organic contaminants will likely only be found in diluted form in leachates, it is unwise to make inferences from experiments performed only with undiluted organic compounds. A better understanding can be obtained by performing a series of sedimentation experiments with a range of organic concentrations.

## APPLICATIONS

Because of past difficulties a variety of approaches ranging from refinement of laboratory measuring techniques to application of probability theory have been attempted to eliminate the uncertainty associated with the determination and application of k (Dunn, 1985). However, the approach suggested in this paper requires that the landfill design engineer look beyond the k value of the soil and concentrate on the behavior of the clay liner as a whole unit.

Considering the uncertainty of test results, k can only provide a first approximation for liner design. However, the cost effectiveness of performing an expensive, time consuming direct permeability test to provide only an approximation is questionable. An alternative would be to perform a synaerisis shrinkage test, which provides information on synaerisis shrinkage behavior and also provides data to calculate an approximate value for k.

We recommend that the sedimentation test could be used as an index test to screen a large number of competing soils for potential synaerisis shrinkage, with a range of leachate concentrations, in a very short time. Determination of FSD values for each soil, with various combinations of test liquids, would provide a good basis for the elimination of problem soils. Thereafter, synaerisis shrinkage tests could be performed on the selected soil. The information on shrinkage and permeability gathered from this test would allow a design engineer to follow either one of the following pathways:

- make a rational decision on the suitability of the clay soil being tested, and if found necessary, to modify the soil,
- make allowance in the design process to incorporate the bulk permeability changes caused by the non-homogeneities expected in the clay liner.

If the calculated k values are undesirably high, the soil could be modified by adding more clay sized particles. The amount of clay sized particles needed should be based upon the k of the soil. However, use of bentonite (Na-montmorillonite) should be avoided whenever possible. If bentonite is applied to the soil, $Ca^{+2}$ should be mixed to suppress the swelling potential of bentonite.

If a high shrinkage is observed, the soil could be modified by adding $Ca^{+2}$ to the soil. The quantity of $Ca^{+2}$ ions needed for a soil with high synaerisis shrinkage potential could be found from the method proposed by Hettiaratchi et al., (1986).

Cracks within a clay liner could form under a variety of conditions, including:

- dessication cracks formed during liner exposure to air before the actual operation of the landfill,
- cracks formed as a result of differential settlement including those caused by synaerisis shrinkage of parts of the liner induced by uneven generation of leachate within the landfill,
- cracks caused by volumetric shrinkage and separation of leachate-

contacted soil from the main soil mass (especially at the edges of the landfill, in clay lined embankments),

- cracks formed during the initial stages of landfill operation, as a result of heavy equipment usage for solid waste compaction purposes.

When there is a high probability of crack formation within a landfill liner, allowance should be made for the increases of the liner bulk permeability during the design stage. Provision of thicker clay liners would lessen the impact of cracks. However, a good understanding of the flow of liquids in clay soils containing cracks and fissures will be needed to design liners with greater confidence.

Several analytical equations are available in the geotechnical and soil science literature, which may help in providing some insight to the problem of liquid movement in cracked soils (Hettiaratchi et al., 1986). Currently, these equations can provide only rough estimates for the equivalent hydraulic conductivity across cracked liners. The situation is complicated because of the lack of experimental or field data on the pattern and extent of cracking within clay liners.

Consequently, liner design in circumstances likely to involve synaerisis shrinkage requires that measures be taken to minimize shrinkage potential while providing additional liner attenuation capacity to account for the uncertainities which still exist.

## ACKNOWLEDGEMENTS

This research was funded by a contract from the Solid Waste Management Branch, Pollution Control Division of Alberta Environment, and an operating grant from the Natural Sciences and Engineering Research Council of Canada.

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# EXPERIENCE IN DESIGN AND CONSTRUCTION OF A STATE-OF-THE-ART SECURE LANDFILL

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Western Canada Division
Dow Chemical Canada Inc.

## I. SUMMARY

This paper addresses the learning experience in the design and construction of a state-of-the-art secure landfill at the Fort Saskatchewan complex of Dow Chemical Canada Inc. in Alberta. The $2.7 million landfill construction project includes an equipment wash facility, two (2) 2,000 cubic meter leachate collection tanks and the solid waste containment cell with a 24,500 cubic meter capacity. The care taken in the process of design and construction of the first Canadian secure landfill with one (1) recompacted clay liner and two (2) synthethic liners ensures the protection of groundwater during the life of the solid waste containment cell.

## II. GENERAL BACKGROUND

In 1961, the Dow Fort Saskatchewan complex opened two plants, one producing chlorophenol used in wood preservation and herbicides for farmers, the other producing glycols and ethanolamines for the gas industry. By 1968, a chlor-alkali plant was added to meet the needs of western Canada's pulp and paper industry for chlorine, caustic soda and salt. In 1974, Dow built a plant to manufacture Styrofoam* brand foam insulation for the construction industry. This was later replaced by a larger foam facility. In 1986, Dow committed $ 1.2 billion to a major expansion of Alberta's petrochemical industry, including the addition of five world scale plants to the Fort Saskatchewan site. These plants produce vinyl chloride monomer, ethylene dichloride, polyethylene, ethylene glycol, ethylene oxide, caustic soda, chlorine and power.

The waste management policy of the Division has been reduction of waste generation, reuse of by-products, recycle of waste whenever feasible, disposal of waste via high temperature incineration or disposal in a engineered designed landfill under supervision. The Division has also practiced prohibition of any chemically contaminated solid waste from leaving the plant site. The increased activities on the site demanded a new secure landfill be constructed to compliment the operation of the world scale plants.

## III. INTRODUCTION

In late 1985, Dow Chemical began the design of a new secure solid waste containment facility (landfill) at the Fort Saskatchewan Site. Realizing the importance of assuring groundwater protection, it was determined that the best technology available, plus further innovative features were necessary in its design.

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* Trademark of The Dow Chemical Company

It is believed that the landfill which has been constructed and its associated facilities: containment, leachate collection and equipment washing, will eliminate any concern of groundwater contamination associated with the disposal of contaminated solid waste at this complex industrial site. The landfill was completed in early 1987.

The experience gained during the design and construction phase of the secure landfill is very useful for future projects with similar scope. Some of the major learning experiences are recorded in this paper.

## IV. DESCRIPTION OF THE SECURE LANDFILL FACILITIES

The $2.7 million landfill project includes several unique features. The location of the landfill was specifically selected due to its most appropriate geology on the site.

The landfill cell occupies an area of 9800 square meters (2.42 acres) and has a capacity of approximately 24,500 cubic metres and measures approximately 140 m x 70 m x 4 m. The cell design which includes two, one hundred mil (100) thick synthetic liners and associated leachate collection systems and a groundwater collection system, is one of a kind in Alberta and possibly in Canada. A schematic of the cell-liner system is shown in Figure 1 and a schematic of the landfill facility plan is shown in Figure 2. Typical bottom cross-section of the secure landfill cell is shown in Figure 3.

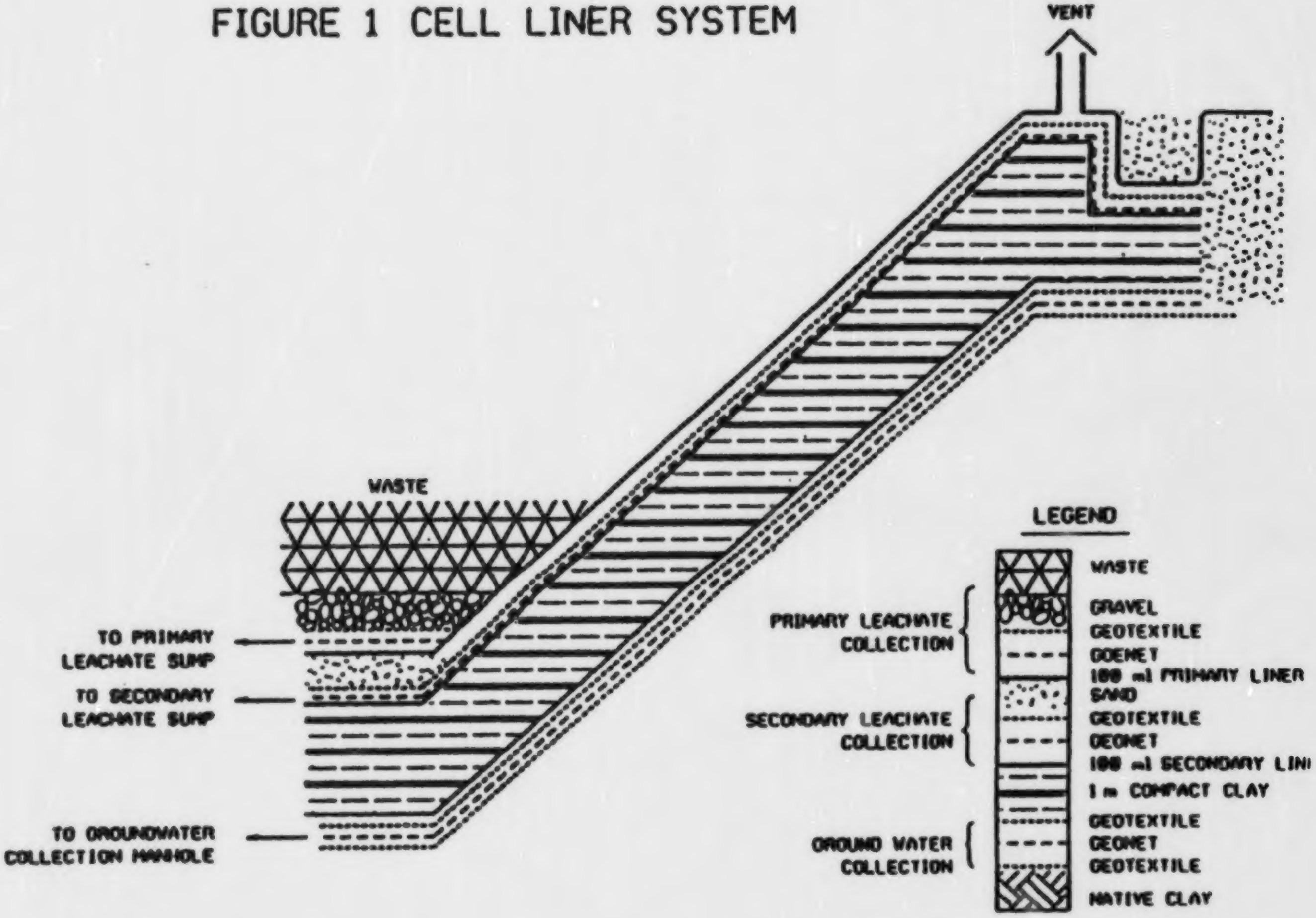
Site selection is very important. The secure landfill site was selected because it was a low permeability geological area with a minimum thickness of 20 meters of native clay.

The cell is built on top of this low permeability zone. At the interface of the clays and the cell, is a groundwater collection system to eliminate the possibility of groundwater impinging on the cell support structure. The support structure is made up of 1 metre of compacted clay, which in itself is an excellent barrier to liquid migration.

Moving up from the support structure, there is a 100 mil synthetic liner, followed by a geonet grid to allow the flow of liquid along the surface of the liner to a collection sump. Over the geonet is a geotextile or filter cloth to prevent clogging of the geonet and then a layer of sand. This combination of liner, geonet, geotextile and sand, is the secondary collection system. Above this is the primary collection system which is comprised of another 100 mil synthetic liner, geonet, geotextile and a layer of gravel. Rainfall, snow-melt and moisture from the waste will be collected by a primary collection system and drain to one of two sumps located within the cell. The liquid collected in the sumps will be automatically pumped to one of two 2,000 cubic metre leachate tanks. The automatic pumping systems at the sumps are designed to ensure the containment cell is kept dry at all times. With minimal hydraulic head in the cell, the vertical movement of the leachates will be reduced.

In the unlikely event that any liquid manages to penetrate the primary liner, further movement will be prevented by the secondary liner. Volumes and quality of liquid collected from each collection system will be monitored. In addition to the protection systems, three groundwater observation wells have been established around the facility to monitor the quality of the groundwater up-gradient and down-gradient of the facility. Similarily, the groundwater collection system beneath the supporting structure will serve as another monitoring mechanism to ensure total containment.

FIGURE 1 CELL LINER SYSTEM


VENT
WASTE
TO PRIMARY LEACHATE SUMP
TO SECONDARY LEACHATE SUMP
TO GROUNDWATER COLLECTION MANHOLE
LEGEND
WASTE
GRAVEL
GEOTEXTILE
GEONET
100 ml PRIMARY LINER
SAND
GEOTEXTILE
GEONET
100 ml SECONDARY LIN
1 m COMPACT CLAY
GEOTEXTILE
GEONET
GEOTEXTILE
NATIVE CLAY
PRIMARY LEACHATE COLLECTION
SECONDARY LEACHATE COLLECTION
GROUND WATER COLLECTION

**DOW CHEMICAL CANADA, INC.**
WESTERN CANADA DIVISION FORT SASKATCHEWAN, ALBERTA

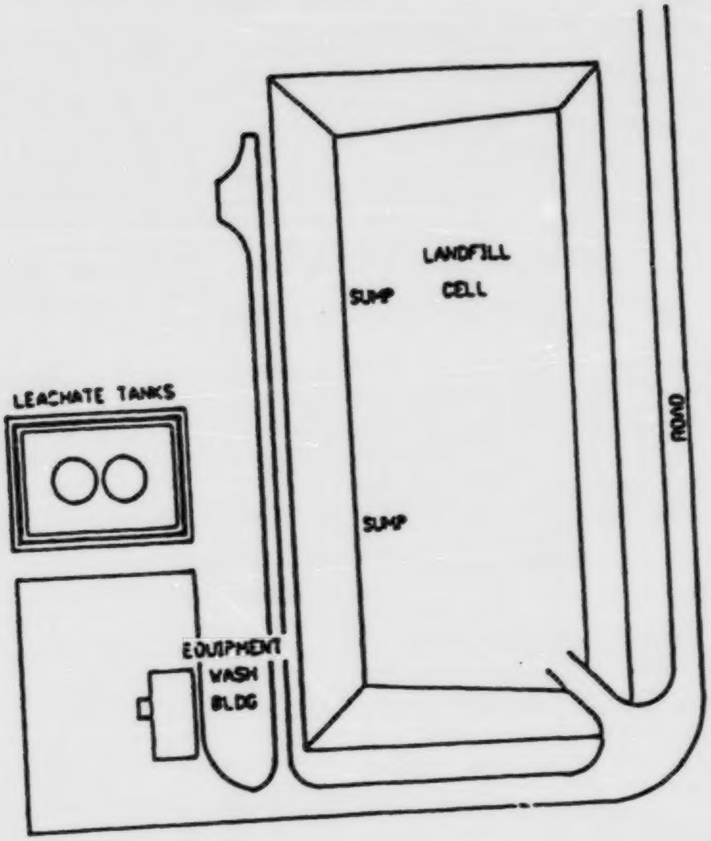

LANDFILL
CELL
SUMP
SUMP
LEACHATE TANKS
ROAD
EQUIPMENT
WASH
BLDG

FIGURE 2. SCHEMATIC OF LANDFILL FACILITY

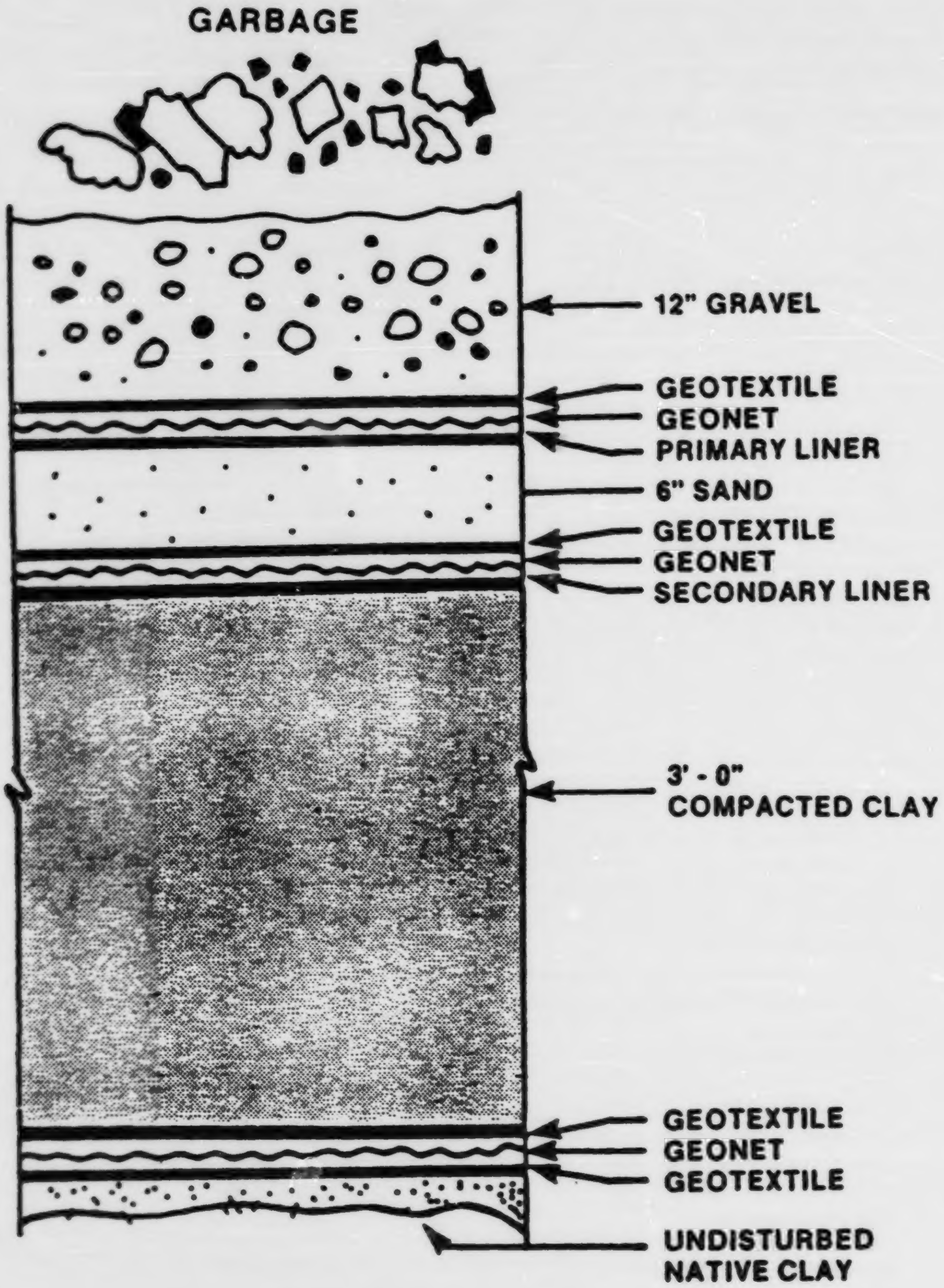

GARBAGE
12" GRAVEL
GEOTEXTILE
GEONET
PRIMARY LINER
6" SAND
GEOTEXTILE
GEONET
SECONDARY LINER
3' - 0"
COMPACTED CLAY
GEOTEXTILE
GEONET
GEOTEXTILE
UNDISTURBED
NATIVE CLAY

FIGURE 3. TYPICAL BOTTOM CROSS-SECTION OF SECURE LANDFILL CELL

The two leachate collection tanks adjacent to the cell are dyked and are each equipped with a unique and innovative leak detection system beneath the tanks. Each tank is insulated and equipped with level alarms.

An equipment wash facility has also been constructed for year-round operation adjacent to the cell. It is required that all equipment which has handled waste within the landfill site, be decontaminated before leaving the site. All wash water and solids will be contained. The liquid will be pumped to the leachate tanks and the solids returned to the landfill.

## V. LEARNING EXPERIENCE

### A. Contract Administration

All design work, contract preparation and contruction supervision was handled by the Dow Engineering and Construction Services group. Internal Dow expertise was utilized in all aspects of the project. This offered an advantage in the coordination and management of the project.

The project is divided into three major contracts: general civil, liner system installation and mechanical contract. A different contractor was used for each contract. The civil contract included the site preparation, landfill cell excavation, recompaction of the three (3) foot clay liner and installation of the dewatering network. The mechanical contract consisted of the erection of the equipment wash building, leachate tanks, pipe rack and sump pumps. The liner system installation contract comprised the installation of the two (2) 100 mil (0.1 inch or 0.25 centimeter) thick polyethylene liners in the landfill cell, the associated geotextile and geogrid leachate collection network and the leachate collection sumps.

The learning experience expressed in this paper concentrates on the liner installation contract since the civil and mechanical contracts are straight forward and learning experience is minimal.

### B. Design

At the time of design, there were no Canadian government guidelines on the design of landfills with synthetic liners. Design principles were based on the Environmental Policy of the Dow Chemical Company in Appendix 1.

The design team started with a visit to other Dow and non-Dow facilities which have operating experience with single and double synthetic liners. Since there is no synthetically lined landfill in Canada, most of the pre-design learning experience was based on U.S. facilities.

i. Geomembrane (Synthetic Liner). It was recognized that a landfill with synthetic liner(s) provides better retardation of landfill leachates than the ones with natural or artificial clay liners because typical permeabilities of synthetic liners range from $10^{-11}$ to $10^{-13}$ cm/sec while clay lines from $10^{-7}$ to $10^{-9}$ cm/sec. Therefore, the decision was made to have a synthetically lined secure landfill for the Fort Saskatchewan operation. Dow management agreed that two layers of synthetically lined cell was preferred in order to provide added protection to the groundwater, although the cost would be automatically doubled for the liner material and labour.

Polyethylene liners were chosen after chemical compatibility tests were performed with the potential leachates of the existing secure landfill. Chemical compatibility data from liner contractors was also evaluated before decisions were made.

Two (2) polyethylene liners with 100 mil thickness were chosen after consideration of durability and weldability were evaluated. It was the thickest polyethylene sheet on the market at the time, which could be thermally welded.

ii. Welding Technique. Geomembranes can be seamed in various ways including thermal weld, solvent seams etc. Since solvent seams will introduce chemicals in the ambient surroundings, it was decided thermally welded seams was the preferred method to adopt. However, there were two welding processes available from different liner contractors, the fusion and extrusion techniques. The advantages and disadvantages of each method were balanced and either technique was considered acceptable for the project depending on the successful bidder.

iii. Geomembrane Performance Criteria. The specification which defined the material properties of the high density polyethylene (HDPE) geomembrane was based on the National Sanitation Foundation, Standard 54 for Flexible Membrane Liners and it was modified in the contract specification. Criteria in NSF Standard 54 modified or added included parameters such as: force per unit width as yield, force per unit width as break, modulus of elasticity, tear resistance, environmental stress crack, carbon black content and carbon black dispersion.

iv. Geomembrane Seam Acceptance Criteria. Since the landfill covered a wide area, field welding of panels of geomembranes was unavoidable. The welded seams were the most vulnerable locations for imperfections. Acceptance criteria set up included mechanical tests, ultrasonics and vacuum box tests. Seam samples were collected in the field according to specification and samples were tested in the field as well as in the laboratory.

v. Inspection. To ensure the quality control and quality assurance protocol were complied with, third party inspection was retained. The liners were inspected during the time of manufacturing, the shop seams were tested and the field installations were also supervised.

vi. Geosynthetics. Other than the selection of geomembranes, the chemical compatibilities of the leachates and the geonet and geotextile were also evaluated. The geonet and geotextile play an important part in diverting the leachates into the sumps. Incompatibility between the geosynthetics and the leachates will retard the drainage rates of leachates.

vii. Leachate Sump Locations. One of the major design requirements was that there would be no penetration of either the primary or secondary liners with any piping, to ensure the integrity of the liners. This requirement effectively limited the location of the two (2) leachate collection sumps of the primary leachate collection system to be inside the landfill cell itself. To locate the leachate collection sumps outside the landfill cell would increase the capacity of the landfill but it may also create a potential pathway for leachate to leave the landfill along the piping route.

The secondary leachate collection system of the secondary leachate network does not penetrate either the primary or secondary liner either. The discharge piping of the secondary leachate collection sumps, exit the landfill between the primary and secondary liners.

viii. Drainage Pattern. The 2.42 acre landfill was designed to have a high ridge in the middle to divert the primary leachate or surface runoff into the two (2) different sumps. The reason is to reduce the volume of the contaminated leachate thus reducing the leachate treatment costs.

In the initial phase of the operation, only half of the landfill would be used and the contaminated primary leachate would be diverted to a leachate collection tank which was destined for treatment. The other half of the unused landfill would have clean storm water and would be diverted to the clean leachate tank for disposal.

ix. Leachate Tank Leak Detection. The two (2) leachate collection tanks were designed to have leak detection systems and guarantee the groundwater qualities. The leak detection system follows the principle of a barrier, a detection method and a recovery mechanism. The system of geomembrane with associated geotextile and geogrid is the barrier to the groundwater. The sample bottle is the detection method and the sump is to facilitate leakage recovery. A schematic of the leak detection system is shown in Figure 4.

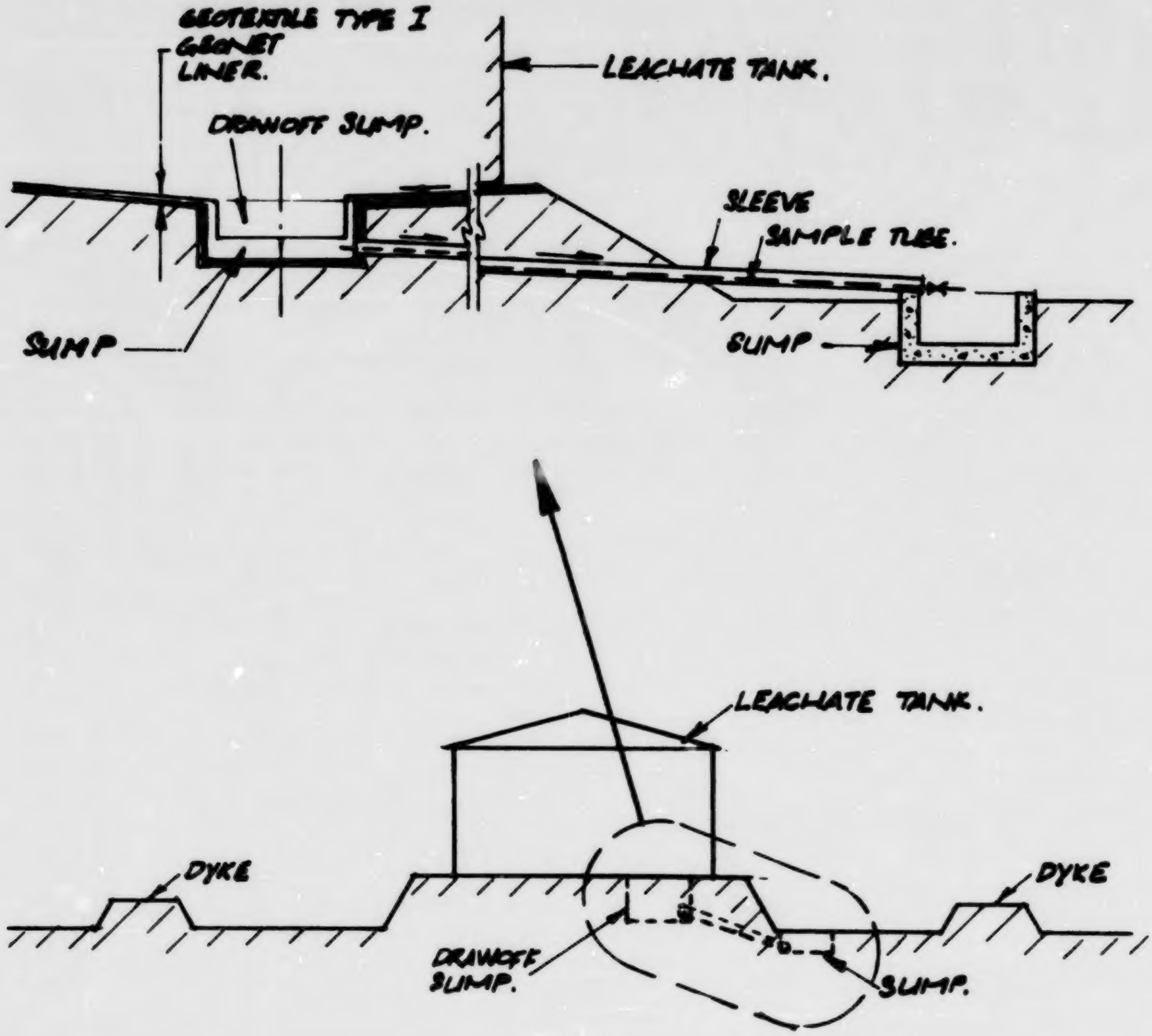
## C. Construction

Due to the short construction season in Alberta, the civil contract and the liner system installation contract were awarded in March 1986. The mechanical contract was awarded three months later. The civil and mechanical contracts were completed on schedule to facilitate the liner installation. However, the learning experience in the liner installation delayed the completion of the liner installation until late 1986.

The width of the geomembrane delivered to the job site depends on which liner manufacturer is selected. Some liner manufacturers were capable of extruding panels with width of more than 10 meters while others could extrude panels of 2 meters and rely on shop welds to seam them together before delivery to the site. Our experience was that the field seams were the most vulnerable locations for imperfections as the less footage one had to weld in the field the better the chance of success. The contractor who proposed the least welding in the field should have the advantage over others in terms of liner integrity.

i. Contractor Selection. Contractors were short-listed based on their prior experience in the number of projects of synthetic lining of surface impoundments and the area of liner they had installed. The learning experience was that the contractor's experience gained in welding 40 or 60 mil liners could not be applied directly to 100 mil liners. Contractors who had a lot of experience in welding 60 mil liners do not necessarily perform satisfactorily during a 100 mil liner project. Project references on 100 mil liner installations should be specified in project.

ii. Welding Techniques. The fusion technique performed satisfactorily and the speed of the welding was faster than the extrusion technique. This was based on different project experience conducted during the same period on site. The quality of the welds performed by both techniques was relatively


GEOTEXTILE TYPE I
GEONET
LINER.
LEACHATE TANK.
DRAWOFF SUMP.
SLEEVE
SAMPLE TUBE.
SUMP
SUMP
LEACHATE TANK.
DYKE
DYKE
DRAWOFF SUMP.
SUMP.

LEAK DETECTION SYSTEM OF THE LEACHATE TANK.

FIGURE 4

the same and the owner had little choice because each contractor normally has experience with only one technique.

iii. Geomembrane Performance Criteria. The geomembrane criteria initially selected was designed for high density polyethylene and the resin chosen for this project was linear low density. Consequently, some of the parameters specified in the criteria had to be modified to be compatible with the material of construction chosen.

iv. Geomembrane Acceptance Criteria. The additives to the polyethylene resin for the manufacturing of the polyethylene liners, have a critical impact on the weldability of the geomembrane. One must ensure that the grade of polyethylene used to prepare the carbon black master batch is fully compatible with the grade of polyethylene used for the sheet entrusion.

The ASTM D 3015 testing criteria for carbon black dispersion does not state rejection and acceptance criteria. A-1 dispersion refers to ASTM D 2663 dispersion of carbon black in rubber compounds which may not apply to polyethylene compounds.

v. Inspection. More than 50% of the liner installation cost was invested in inspection. The industry average inspection cost ranged 35 - 50%. Although quality control and quality assurance procedures were emphasized in the contract specification, it was found that the QA/QC procedures of all the geomembrane manufacturers could be improved. Due to the high demand for geomembranes in the U.S., the manufacturers spent the majority of their effort in meeting prduction demands.

A tremendous amount of effort was invested in the inspection and testing of geomembranes at various stages of the project, the results indicated there was a distinct difference between what the contractor claimed they thought they could do and what they could actually perform. This does not apply to only one single liner contractor but to all the liner contractors who were under study in various liner installation projects during the same period of time. Furthermore, it was indicated that most owners did not invest the same effort and cost in the testing of the liner installations as Dow did. Tests performed included tensile shear strength, tensile shear elongation, peel strength and percent peel separation.

vi. Leachate Sump Locations. The lining of the sump vicinity portion of the landfill was the most challenging part of the project. The sumps were situated inside the landfill cell near the toe of the west slope. The clay support was prepared and it was sloped down from the side of the cell in multi-angled slopes. Due to the relatively irregular shape of the sump area, the lining contractor used numerous working days in designing and cutting the 100 mil thick liner to fit the multi-angled structure and to pass all the test of seam strength etc. The learning experience was that the 100 mil thick liner was not very flexible in lining irregular shaped structures. The support structure contours in the sump area must be designed to minimize the number of seams in the liner and provide smoth contours in this critical area. It could either be pre-molded and installed in the field or the structure could be redesigned to facilitate the liner installation.

vii. Geomembrane Installation. The contractor was instructed to allow sufficient slack in the design to compensate for the extreme temperatures of -50 to 50 degree centigrade. There were projects in the US where insufficient slack was allowed in the liner and resulted in lifting of bottom liner at certain locations during winter. In our learning experience, the overcompensation of the liner to allow for thermal expansion resulted in "expansion bubbles" along the toe of the slopes on all sides. To avoid kinking the bubbles, additional sand was used to cover all the bubbles to allow for even loading on them. This corrective measure reduced the usable capacity of the landfill.

## VI. CONCLUSION

The advancement of technology in the design and construction of landfills has progressed by leaps and bounds in the past several years due to the surge of new projects which include specific features to ensure the protection of groundwater and the enhancing legislation in the U.S. The design and construction of a state-of-the-art secure landfill in the Dow Fort Saskatchewan complex, will ensure secure containment of solid waste and the protection of groundwater. The experience gained by the project team, particularly in the specification, inspection and supervision of the liner installation, was invaluable in ensuring the quality of this important aspect of the porject.

The strong commitment from Dow management to provide the leadership and stewardship in protection of the environment, enabled this project to become a reality.

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# ENVIRONMENTAL POLICY

## The Dow Chemical Company

The Dow Chemical Company is committed to continued excellence, leadership and stewardship in protecting the environment. Environmental protection is a primary management responsibility as well as the responsibility of every Dow employee.

In keeping with this policy, our objective as a company is to reduce waste and achieve minimal adverse impact on the air, water and land through excellence in environmental control.

MARCH 15, 1984

**APPENDIX 1**

DOW

# THE OIL DROP - ALBERTA'S SMALL-SCALE MATERIAL RECOVERY AND APPROACH TO COLLECTION OF USED LUBRICATING OIL

Alberta Environment

T.C. Rogers

Paper unavailable at time of printing

# MANAGEMENT OF HOSPITAL WASTES IN CANADA

## A PRESENTATION TO THE
## 9th NATIONAL CONFERENCE ON WASTE MANAGEMENT IN CANADA

by

**DAVE CAMPBELL**
**SENIOR PROJECT ENGINEER**
**ENVIRONMENT CANADA**

## INTRODUCTION

The field of hazardous waste management has emerged as a major public concern in the 1980's. An important component within this field, is the proper management of wastes generated by our hospitals.

This paper will address the subject of hospital waste management by providing a brief synopsis of two program elements in which Environment Canada is contributing to the improvement of practices in this area of waste management.

The first project is derived from an Environment Canada study on Biomedical Waste. Under this project a state of the art report on the management of hospital wastes in Canada has just been completed. The content and results of this study will be briefly discussed.

The second element involves Environment Canada's efforts to promote exemplary hospital waste management through participations in Federal/Provincial workshops and committees. The results of a Federal/Provincial workshop on hospital waste will be briefly discussed.

## State of the Art Report on the Management of Biomedical (Type A) Wastes in Canada

Environment Canada completed a report entitled "State of the Art Report on the Management of Biomedical (Type A) Wastes in Canada" which is now being prepared for publication. Although the report includes information on non-hospital services such as veterinary clinics, Medical & Health labs etc., the primary focus is on hospital wastes since they are the largest generators of Biomedical (Type A) Wastes in Canada.

The Table of Contents of the report is shown in Figure 1.

FIGURE 1

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ABSTRACT

RESUME

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9. REFERENCES

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In the Introduction, the definition of Biomedical (Type A) Waste is given. With regard to hospital wastes, Biomedical (Type A) Wastes can be described as infectious wastes plus human anatomical wastes. From a practical point of view the only remaining non Biomedical (Type A) Waste in a hospital is the kitchen wastes, since most hospitals have found it difficult to segregate infectious from non-infectious wastes.

The definition of Biomedical Waste is important because it has caused confusion in the past, particularly as regards its hazardous nature. From the view point of hospital waste managers, it is important to ensure that non-hazardous wastes are not labelled as hazardous, because their cost of handling and disposal are far greater than ordinary wastes.

An additional problem arises when these wastes are transported off-site for treatment and disposal since they then fall under the jurisdiction of the Federal and Provincial transportation of dangerous goods regulations. Under these regulations, hospital wastes are represented by a list of specific viruses under an infectious waste category. This method of classification has caused considerable debate about whether or not infectious wastes from hospitals are in fact being transported off-site. This issue will be discussed in more detail in the second part of this paper.

Section 2 and 3 of the report covers biomedical waste generators and generation rates. In Canada, the majority of biomedical wastes are from the following sources:

HOSPITALS
VETERINARY SERVICES
MEDICAL & HEALTH LABS
RESEARCH & DEVELOPMENT LABS

These facilities generate the annual quantities of biomedical wastes shown in Table 2.1. There are 3 things to note in this table.

(1) The spread in the quantity of hospital biomedical waste is probably due to the fact that each hospital has its own definition of what constitutes Biomedical Waste.

(2) The quantities of wastes from the non-hospital services are relatively small.

(3) The quantity of biomedical waste is relatively small compared to the total hazardous waste problem.

TABLE 1 BIOMEDICAL WASTE GENERATION IN CANADA

| Sources | Quantities (tonnes/year) |
|---|---|
| Hospitals | 4000 - 27000 |
| Others | |
| - Veterinary Services | 1200 |
| - Medical and Other Health Laboratories | 1500 |
| - Research and Development Laboratories | 1600 |
| Canada (Biomedical) | 8300 - 31300 |
| Canada (Hazardous Wastes) (Gore and Storrie (1982)) | 3,280,000 |
| % of total | 0.25 - 0.95 |

Table 1 is based on Table 2, showing the number and size of the hospitals, and Table 3 giving the generation rate on a per bed, per patient and percent of total waste. Additional information will be found in the report on waste composition, heating values and the sources of waste within hospitals as well as data on waste rates from non-hospital sources.

In summary, we are dealing with approximately 20,000 tonnes of biomedical wastes per year of which 15,000 tonnes/yr are from hospitals. Although this only represents a small percentage of the total hazardous waste quantity of 3,280,000 tonnes/yr, the location of these wastes, factors in a "risk of exposure" that makes these wastes far more imortant than their numbers would indicate.

Section 4 of the state of the art report deals with current management practices in Canada. This is the first area in which the author had difficulty obtaining good data in this field. Although scattered information was available, it was not enough to compile a complete picture of current waste management practices throughout Canada. The reason for this situation is due to the fact that some regions treat hospital wastes as a separate entity, whereas others tend to combine hospital waste data together with data from other sectors in their general waste management program, thereby making it more difficult to retrieve it readily to serve the needs of researchers.

However, there are examples of practices within regions that will give one an idea of how this waste is managed. In this Province (Alberta) a 1975 study on solid waste management provided the data on hospital waste management shown in Table 4. In addition, at the bottom of the table, data on two Maritime provinces is also shown which include liquid wastes that are directed to the municipal sewer system.

These data point to practices and attitudes towards hospital wastes that are worth noting. For instance, hospitals across Canada continue to landfill infectious wastes and autoclaving, a seeming panacea to virus problems, gains minimal acceptance because of its impracticability for all biomedical wastes.

Incineration and landfilling, of some treated but mostly untreated biomedical wastes, continue to be the methods used across Canada for the disposal of biomedical wastes.

Section 5 covers the best available management technologies for hospital wastes. There are four major areas of interest in this sector:

(1) IN-HOUSE HANDLING
(2) IN-HOUSE TREATMENT & DISPOSAL
(3) TRANSPORTATION OFF-SITE
(4) OFF-SITE TREATMENT AND DISPOSAL

The following is a discussion of these four areas together with the recommendations in Section 8 of the state of the art report:

## In-house handling

Descriptions are given of the handling and storage of biomedical wastes in colour-coded bags and in refrigerated storage areas. In addition, the on-site handling of these wastes by gravity chute, pneumatic tube systems and self-propelled carts are also described. The major recommendations from this section are that biomedical wastes should be contained in colour-coded bags and stored in refrigerated rooms.

TABLE 2 BED SET UP FOR USE DISTRIBUTED BY SIZE GROUPS ADAPTED FROM *CANADIAN HOSPITAL DIRECTORY*, CHA, 1985

| | Size Groups (number of beds per hospital) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1-9 | | 10-24 | | 25-49 | | 50-99 | | 100-199 | | 200-299 | | 300-499 | | 500+ | | TOTAL* | |
| Provinces Territories | Inst. | Beds | Inst. | Beds | Inst. | Beds | Inst. | Beds | Inst. | Beds | Inst. | Beds | Inst. | Beds | Inst. | Beds | Inst. | Beds |
| Yukon and N.W.T. | - | - | - | - | 2 | 59 | 2 | 122 | - | - | - | - | - | - | - | - | 4 | 181 |
| B.C. | 17 | 75 | 14 | 232 | 23 | 836 | 25 | 1839 | 19 | 2667 | 12 | 2922 | 10 | 3784 | 13 | 8684 | 133 | 21039 |
| Alberta | - | - | 15 | 244 | 60 | 1979 | 45 | 2863 | 16 | 2112 | 9 | 2031 | 6 | 2196 | 9 | 8106 | 160 | 19531 |
| Saskat. | 8 | 64 | 69 | 1065 | 31 | 1000 | 12 | 813 | 4 | 561 | 7 | 1673 | 5 | 1898 | 1 | 548 | 137 | 7622 |
| Manitoba | 7 | 54 | 37 | 612 | 16 | 540 | 6 | 415 | 8 | 941 | 1 | 252 | 6 | 2153 | 4 | 3229 | 85 | 8196 |
| Ontario | 4 | 28 | 36 | 655 | 36 | 1323 | 63 | 4704 | 51 | 7206 | 35 | 8719 | 45 | 17424 | 33 | 22654 | 303 | 62713 |
| Quebec | 1 | 7 | 13 | 213 | 39 | 1465 | 39 | 2742 | 54 | 7328 | 36 | 8888 | 35 | 13136 | 20 | 14531 | 237 | 48310 |
| N.B. | - | - | 5 | 80 | 7 | 260 | 11 | 853 | 5 | 702 | 3 | 670 | 4 | 1662 | 2 | 1304 | 37 | 5531 |
| Nfld. and Labrador | - | - | 10 | 187 | 11 | 386 | 4 | 273 | 3 | 412 | 3 | 730 | 3 | 1152 | 1 | 525 | 35 | 3665 |
| N.S. | - | - | 9 | 139 | 7 | 230 | 14 | 964 | 12 | 1732 | 3 | 651 | 3 | 1149 | 1 | 800 | 49 | 5665 |
| P.E.I. | - | - | 2 | 46 | 1 | 33 | 3 | 163 | 2 | 353 | - | - | 1 | 352 | - | - | 9 | 947 |
| TOTAL* | 37 | 228 | 210 | 3473 | 233 | 8111 | 224 | 15751 | 174 | 24014 | 109 | 26536 | 118 | 44906 | 84 | 60381 | 1189 | 183400 |

* Excludes HWC, DVA, Industrial, Solicitor General and Institution Beds.

TABLE 3 SUMMARY OF GENERAL AND BIOMEDICAL (TYPE A) HOSPITAL WASTE GENERATION RATES REFERENCED IN AMERICAN AND CANADIAN SOURCES (SUMMARY OF APPENDIX 2, 3 and 4)

| Type of waste | Sources | Generation Rate |
|---|---|---|
| General | American | (a) 3.52 - 6.43 kg/patient/day<br>(b) 4.28 - 4.39 kg/bed/day |
| | Canadian | (a) 3.34 - 3.83 kg/patient/day<br>(b) 2.92 kg/bed/day |
| Biomedical - Type A | Canadian (1971-1985) | (a) 0.227 - 0.634 kg/patient/day<br>(b) 0.196 - 0.408 kg/bed/day<br>(c) 2 - 10% of total wastes<br>mean (a) 0.43 kg/patient/day<br>(b) 0.30 kg/bed/day<br>(c) 6% of total wastes |

TABLE 4

## A. ALBERTA SOLID WASTE MANAGEMENT SURVEY - 1975

### Urban Hospitals (24 surveyed)

| 1) Internal Handling | Percentage |
|---|---|
| 1. Double bag contaminated waste | 54% |
| 2. Autoclave dressings & biological waste then landfill | 4% |
| 3. Segregate sharps at source for separate disposal | 46% |
| 4. Segregate combustible & non-combustible | 54% |
| **2) Disposal** | |
| 5. Incinerate contaminated & combustible, landfill rest | 50% |
| 6. Incinerate contaminated only, landfill rest | 4% |
| 7. Landfill all their wastes | 33% |

### Small Community Hospitals (126 surveyed)

| 1) Internal Handling | Percentage |
|---|---|
| 1. Double bag contaminated waste | 69% |
| 2. Autoclave contaminated waste | 2% |
| 3. Segregate sharps for special handling | 9% |
| **2) Disposal** | |
| 4. Incinerate contaminated & combustible, landfill rest | 64% |
| 5. Incinerate contaminated only, landfill rest | 16% |
| 6. Incinerate paper waste, rest landfilled | 5% |
| 7. Landfilling of all wastes | 12% |

## B. MARITIME PROVINCIAL PRACTICES

| Disposal/Province | Nova Scotia | New Brunswick |
|---|---|---|
| Sewage System (treated or not) | 40% | 42% |
| Incineration | 2% | 25% |
| Landfill (treated or not) | 58% | 33% |

### In-house treatment and disposal

Steam sterilization (autoclaves) dry heat sterilization, gas/vapour sterilization, chemical desinfection, and irradiation are described and compared. In addition, on-site incineration and discharge to the sanitary sewers are disposal methods which are considered. The major recommendations from this section are that liquid biomedical wastes can be discharged to the sewage system if it is properly sterilized and that the conventional "hot hearth" incinerator be used for anatomical wastes and that a controlled air incinerator with gas cleaning equipment be used for the other incinerable wastes.

### Transportations Off-site

Off-site transportation of biomedical wastes are discussed. The major recommendations are that the vehicles should be specially designed for this purpose. They should be insulated and refrigerated and clearly marked as per the Transportation of Dangerous Goods Regulations (TDGR). The wastes should be manifested as an infectious waste unless they are sterilized prior to transport.

### Off-site treatment and Disposal

The three offsite treatment and disposal methods of landfill, incineration and the sanitary sewer are described and analyzed. The recommendations for sanitary sewer discharge are given in number (2) as well as the incinerator recommendations In addition, recommendations for off-site "regional" incinerators are that additional effluent testing to ensure compliance with existing and pending emission criteria are needed. This is an emerging area that will be further discussed in the second part of this paper. With regard to landfilling, it is recommended that biomedical waste be sterilized prior to landfilling until such time as studies are available which prove or disprove the contention that landfilling infectious wastes endangers the public health.

A summary of these recommendations are as follows:

(1) Biomedical wastes should be stored in colour-coded garbage bags that are accepted nation-wide.
(2) Storage areas should be refrigerated.
(3) Liquid discharges to the sanitary sewer must be sterilized.
(4) The conventional "hot hearth" incinerator should be used to incinerate anatomical waste until such time as it can be proven that the controlled air incinerator, or its equivalent, with gas cleaning equipment should be used for the other incinerable wastes.
(5) Insulated, refrigerated vehicles properly labelled and the waste manifested as per the TDGR should be used for biomedical waste transportation.
(6) Large regional biomedical incinerators should be further studied to optimize their performance requirements.
(7) Biomedical infectious wastes should be sterilized prior to landfilling.

The second part of this paper concerns efforts made by Environment Canada and its provincial counterparts to promote exemplary hospital waste management. Although hospital wastes were targetted for appraisal under Federal & Provincial waste management programs, their profile was enhanced by adverse publicity surrounding start-up and operating problems associated with the first regional hospital waste incinerator located in Gatineau, Que. It became apparent to Quebec, Ontario and Environment Canada that there were deficiencies in existing regulatory requirements for the handling, transportation, treatment and disposal of hospital wastes.

These three governments are mentioned because at the time this regional incinerator was accepting waste from the following sources:

| Origin | Waste Percentage |
|---|---|
| Quebec | 10% |
| Ontario | 50% |
| U.S. | 40% |
| | 100% |

To help address the problems of regional incinerators, on April 6, 1987 Environment Canada conducted a workshop on hospital waste management. In addition to several Federal Departments, Ontario and Quebec representatives were also invited along with Alberta because of its extensive program on hospital waste incinerator upgrading.

Three major areas were addressed and the resulting conclusions were as follows:

## Need for uniform definition of hospital wastes

Background. Several definitions of hospital wastes are presently in use from the viewpoint of hospital waste management and from the viewpoint of the Transportation of Dangerous Goods Act (TDGA). These differences resulted in regulatory confusion in dealing with the international shipment of hospital wastes from New York State to the Regional Hospital Incinerator Plant in Gatineau, Quebec. From this situation it became apparent that varying interpretations of the TDGA existed with regard to infectious wastes.

Recommendation. Consideration should be given to establishing and adopting a national definition for hospital wastes and that Transport Canada be approached to achieve an agreement on including hospital wastes as an additional waste stream in the Waste Package amendments to the TDGA. (Transport Canada has recently suggested to Environment Canada that pathological and infectious hospital wastes be included as a waste type in the amendments and in mid-August Environment Canada accepted this suggestion).

## On-site Handling, Treatment & Disposal

Background. Procedures for the proper on-site handling, treatment and disposal of hospital wastes have also caused problems for regulators. The most notable of these is the on-site incinerator. The majority of hospital waste incinerators across Canada will not meet todays new standards for gaseous, liquid and solid emissions. The cause is primarily due to the emergence of disposable plastic equipment which has elevated the plastic content of hospital waste to levels as high as thirty percent by weight. Incinerators, originally designed for burning tissue, are now required to consume wastes at the other end of the spectrum in terms of heat release and combustion air requirements, resulting in a combustion environment that favours the production of dioxins and furans and other pollutants.

In addition to incinerators, the problems associated with autoclaving, chemical treatment and other pre-disposal methods have caused confusion within the various jurisdictions in charge of hospital waste management. These problems are centered on the extent to which these methods are used on infectious wastes and their potential for handling all infectious wastes.

Finally, the problems associated with waste handling, particularly as regards the use of colour-coded garbage bags, have also caused concerns. Across Canada, several systems are in place for identifying types of hospital waste by coloured bags or by container type. A uniform system would enhance safety, particularly if these wastes are to be transported off-site.

## Recommendations/Status

On-site Incinerators - The Ontario Ministry of the Environment is in the process of conducting extensive emission tests on ten types of hospital incinerators within their jurisdiction. Emission testing will include dioxins and furans. The results of their testing program should provide adequate background data to determine the emission characteristics of existing on-site incinerators and to provide a foundation for future design of larger regional incinerators.

Autoclaving, Chemical treatment etc. - A report on autoclaving and chemical treatment will be made available by the Ontario Ministry of the Environment. In addition, the Quebec Ministry of the Environment will provide a more detailed study on characterizing hospital wastes and on microwaving infectious wastes.

Colour coded bags - The Canadian Standards Association (CSA) and several provinces are promoting the use of a system relating hospital waste types to a specific coloured garbage bag. (e.g. human anatomical waste is required to be placed in a red garbage bag). Consideration should be given to adopting national colour coding of hospital waste garbage bags to ensure ready identification of waste type irrespective of jurisdiction.

## Off-site Disposal

Background. This section will focus on disposal by off-site landfills, sewers and incinerators.

Landfills and Sewers. In some regions of Canada, hospital wastes are landfilled and in other regions this practice is banned. Some experts claim that pathogens will not survive 24 hours in a landfill while others claim that even if this were true, scavengers may pick up the infected material before it is properly buried and endanger the public. A similar controversy surrounds directing the disposal of liquid waste to the sewer system.

Recommendation. Consideration should be given to instituting a policy on the efficacy of directing hospital wastes to landfills and sewers with and without pre-treatment.

Incinerators. Regulations for hospital waste incinerators were developed to address small incinerators located on hospital premises. These regulations usually increased the operating temperature and retention time of the combustion process and then treated the incinerator as a normal "packaged" incinerator. As a relatively small source of pollutants, these incinerators were not high on the list of concerns of regulators. However, the emergence of large regional hospital waste incinerators caught regulators off-guard because a large source of HCl and dioxin and furan emissions could not be considered insignificant. An additional complication was the emergence of hospital waste incinerators as the source of dioxins and furans of major concern; supplanting energy from waste plants.

Although sufficient data are not yet available on the emissions from small hospital incinerators or their larger counterparts to determine if this is in fact the case, their combustion conditions make them a prime suspect.

With regard to the movement towards installing large regional hospital incinerators, the Province of Ontario is projecting that they will have 12 operating in the various regions in their province in the future. Although their present testing program on existing hospital incinerators will address dioxins and furans, these tests will not be conducted on any incinerator with emission control equipment and it is a virtual certainty that their future proposed incinerators will have scrubbers and/or dust collectors.

The Incinerator Plant in Gatineau is one of first of this new generation of regional hospital waste incinerators in Canada. Flakt scrubbers are now being installed on the incinerators and completion is projected for this October, 1987. Thorough emission testing of these incinerators with their new scrubbers could produce data readily comparable to the NITEP data on dioxin and furan removal obtained at the municipal solid waste incinerator in Quebec City.

The Province of Alberta has several large hospital waste incinerators that are equiped with boilers and scrubbers. This Province instituted an impressive program to ensure that the performance of their hospital waste incinerators met strict particulate and HCl standards. Due to economies of scale and the high cost of boilers and scrubbers, several larger hospital waste incinerators were built servicing several hospitals. These incinerators, which in some cases are larger than the Gatineau Incinerator Plant, were tested for particulates and HCl but not for dioxins and furans.

Recommendations. Any siting of a new regional hospital waste incinerator in Canada will be confronted with the need to provide reliable estimates of dioxin and furan emissions. No such data exist at the present time for large controlled air incinerators with boilers and scrubbers, nor are these data anticipated from the Ontario studies on existing incinerators.

To correct this problem, consideration should be given to instituting a Testing of Regional Hospital Incinerator Program at one regional hospital incinerator located in Canada. This program would provide emission data for future installations of this nature.

General Conclusion/Recommendations. In analyzing the state-of-the-art report and the results of the workship on hospital waste management the following major conclusions and recommendations can be established:

1) A national definition of biomedical wastes is required from the point of view of waste managers. The definition from the point of view of the TDGA appears to be approaching resolution as of August, 1987.

2) A scheme for colour-coding garbage bags relative to the waste type within the hospital waste category needs to be implemented nation-wide.
3) A national policy on the discharge of infectious wastes to landfills and to sewers is needed.
4) More extensive performance data on biomedical waste incinerators is required to ensure that the new regional incinerators will meet the more stringent hazardous waste incinerator criteria being produced by Federal/Provincial committees.

# LIABILITIES AND RISKS ASSOCIATED WITH THE MANAGEMENT OF BIO-HAZARDOUS WASTE

by Robert A. Spurgin

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As a natural consequence of providing for the improved quality of life of the people they serve, health care institutions generate a variety of hazardous wastes in both small and large quantities. Of the total spectrum of these hazardous wastes, by far the largest volume is that which can be considered infectious or bio-hazardous. This paper will explore in detail the occupational as well as environmental health hazards associated with this particular type of waste, along with the liabilities and risks that result should the waste be improperly managed.

Infectious waste (the term here would be used here synonymously with bio-hazardous), poses specific occupational health risks to employees and other personnel coming into direct contact with this particular waste stream. The incidence of needle sticks and other injuries from other hazardous sharps puts a health care worker or other employee at risk to contract a variety of communicable diseases, particularly hepatitis B. There are cases of health care workers and solid waste handlers who routinely report injuries on the job related to this particular type of waste. These injuries are usually the result of waste that has been improperly packaged and managed. Two recent incidents dramatically illustrates this point. In early May, two 5 year old boys climbed into a trash dumpster behind a medical building in Youngstown, Ohio. Inside were hundreds of intact unboxed needles and syringes which the boys used to play "doctor". Less than a month later, approximately twelve youngsters were playing in and around an Indianapolis clinic dumpster filled with broken vials containing untreated blood samples from patients with a variety of communicable diseases, including AIDS. While initial tests on the children have proven negative, the tragedy here is that in those areas, it is perfectly legal to dispose of those items in that manner. But clearly, unauthorized "visitors" to the dumpsters are not the only ones at risk. From the nurse who administers the treatments to the janitor who transports the waste out of the facility, to the refuse hauler and the landfill worker, all are at a significant occupational health risk with such practices.

There are environmental risks as well. Bio-hazardous waste transported to a landfill untreated, can pose a risk of disease transmission should birds, rodents, or insects be present at a given landfill. Since such animals are there to forage for food, the possibility of disease transmission is a very real one. Additionally, the compaction of untreated infectious waste in standard refuse vehicles or stationary compactors, can result in the aerosolization of pathogens which then can be transmitted by airborne route. Tuberculosis is one such transmittable disease.

A case in point is a series of incidents occurring a few years ago in California, where solid waste refuse vehicles (in this case front-end loaders) picked up solid waste and infectious waste which had been packaged separately and compacted them together in the vehicle. The result was expulsion of blood from some blood suction cannisters that spilled onto the parking lots and street. In one case this leakage occurred at a truck stop in Los Angeles which is the major embarkation point for California agricultural products.

Environmental health issues also can involve the treatment processes for infectious waste either on-site or off. Recent studies of hospital incinerators have raised questions regarding the viability of terminal sterilization under routine conditions. It is certain that inadequate temperatures in these incinerators might not only result in the expulsion of microorganisms and other pathogens into the atmosphere, but the possibility of creating various hazardous gases and toxic emissions in the combustion process itself. This stack gas issue is important to consider as well.

What are the potential consequences of such mismanagement? Due to the nature of the waste stream these risks are extremely difficult to quantify. However, where infectious waste is regulated as hazardous, liability clearly rests with the generator. Legal precedent was established when the Los Angeles County District Attorney filed criminal charges against almost two dozen hospitals in a two year period for improper (and sometimes negligent) handling of infectious waste.

In the most severe case, a hospital administrator was held personally responsible and was charged with criminal negligence. He was convicted and placed on probation. At the other extreme, landfill privileges were denied many hospitals which did not comply with the law.

But, what about those areas where infectious waste is not regulated as hazardous? What risks are faced even in the absence of regulatory controls? We have discussed both he environmental and occupational health risks, but who bears the liability or consequences? Perhaps a few examples of incidents which have occurred will serve to illustrate the point:

1. A mechanic working on a DP Caterpillar Tractor is underneath the vehicle when he is punctured by a needle imbedded in the undercarriage of the equipment.

2. A refuse hauler arriving at the landfill opens the back door of his refuse truck to dump the waste and fluid spills out covering his arm.

3. A hospital employee is removing a bag of waste from the hospital floor and as he grabs the bag, he is stuck with a needle.

In each of these instances, the likely consequence would include a workers compensation claim being filed against the employer and the employer being held responsible, for this is an issue of worker safety or occupational health.

The bottom line, ladies and gentlemen, is that we are all at risk for the potential mismanagement of infectious waste. While very difficult to quantify, the hazards are nonetheless there. It is not an issue that will go away. Rather, it is our responsibility to form a partnership between generators, haulers, and disposal facilities to ensure proper disposal not only for a safe environment in general, but a safe work place in particular.

# CONTROL OF EMISSION FROM MUNICIPAL INCINERATORS

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## ABSTRACT

Two recent seminars have addressed the problem of trace emissions from municipal solid waste incinerators; the first on heavy metals, principally cadmium and mercury, the second on organics, principally dioxins.

With regard to both metals and organics such as dioxin the two seminars concluded that a high level of control of particulates and acid gases did much to reduce emissions to levels within acceptable limits. There is a marked similarity in the behavior, though not the chemistry, of mercury and chlorinated dioxins. Mercury changes its chemical state and dioxins are synthesized as the furnace gas looses heat, as in a boiler. Both are absorbed on particulate matter and both can therefore be efficiently removed by good solids control. For both substances one of the more efficient processes is wet scrubbing with lime followed by fabric filtration.

A recent temporary Swedish ban on construction of municipal incinerators was lifted after 16 months when studies showed that modern incinerators can be operated to limit dioxin and other emissions to acceptable levels. Various methods for estimating the toxicity of mixtures of dioxin isomers do not appear to give results that differ by more than the admitedly large errors in analytical determinations.

In the Federal Republic of Germany no emission limit on dioxins is considered practical because of analytical consideration, instead limits are set on furnace parameters and selected emissions including CO, particulate matter, HCl and Hg+Cd.

## 1. INTRODUCTION

The revised interest in inceration of municipal solid waste (MSW) arises from the fact that in most densly populated areas there is not enough space for landfills plus the fact that acceptable landfills that do not cause pollution of the environment are no longer cheap. Recent European developmnents in the utilization of hot water for district heating and North American developments of efficient low capacity generators of electricity have revived interest in the use of MSW as a fuel with the accompanying reduction of the volume that will require eventual disposal as ash.

Before incineration of MSW can be accepted it must be shown that it need not cause unacceptable environmental pollution. Earlier incinerators, varying from open burning dumps to large municipal incinerators did in fact emit large quantities of particulates, heavy metals, free acids, and dioxins. This earlier data has been used by opponents of incineration who frequently disregard or even disparge more recent results. The two specialized seminars discussed in this paper attempted to review the current state of the art of MSW incineration and evaluate incinerator performance in the light of national regulations, public health and environmental pollution. Both seminares werre sponsored by ISWA (The International Solid Wastes Association) in cooperation with its Danish member association,DAKOFA.The dioxin seminar was also sponsored by the European Regional Office of the World Health Organization.

The first seminar showed that modern incinerators fitted with good collectors for fly ash released less dust, cadmium and SOx and about the same mercury as a good coal-burning power plant. The second seminar showed that dioxin and other identified organic emissions are also well within acceptable limits for inhalation and also far below levels found in other sources such as food.

## 2. HEAVY METALS AND PARTICULATES

Concern for emissions of heavy metals is limited to mercury and cadmium. These were the only two that occur in troublesome concentrations. Both occur in a volatile form in the firebox and must be removed by condensation and adsorption on particulates. Mercury is easily reduced to Hg metal vapor in the starved oxygen regions of flames in the neighborhood of burning solids. It is oxidized by free oxygen in the flue gases and appears to be predominantly in the form of $HgCl_2$ in the collection stages. According to Bergstrom (1986) the oxidized mercury is effectively attached to fly ash during filtration. A high degree of collection, up to 90%, can be obtained by injecting lime and fly ash before a fabric filter. Better removal of HCl occurs below 140°C but there is little improvement in mercury removal. Vogg et al (1986) showed that cadmium, primarily as $CdCl_2$, is collected with 99% efficiency when fly ash is reduced to 20-30 mg dust per normal cubic meter.

In his summary paper Hansen (1986) showed that emissions of dust, acids and metals from MSW incinerators were comparable to that emitted by modern coal fired power plants even when calculated per unit of energy produced. Table1 shows the high average emissions from older Danish MSW incinerators, many of which had little or no particulate removal devices, the improvements available with electrostatic precipitators (ESP) and the further improvements produced by bag filters and lime treatment.

TABLE 1

EMISSION OF POLLUTANTS IN GRAMS PER GJ OF POWER

| | Dust | HCl | SOx | Cd | Hg |
|---|---|---|---|---|---|
| Coal,Denmark 1984 | 60 | 15 | 800 | 0.008 | 0.007 |
| MSW,Denmark 1984 | 270 | 400 | 370 | 0.19 | 0.21 |
| MSW,Typical of ESP only | 50 | 400 | 370 | 0.08 | 0.21 |
| MSW,Additional cleaning (seminar reporting) | 5 | 30 | 100 | 0.00004 | 0.01 |

Further reduction of mercury and cadmium can only be obtained by source control, primarily by separate collection of batteries.

## 3. DIOXINS

### 3.1 Control of emissions

Regardless of where they are formed the polychlorinated dioxins are strongly adsorbed on surfaces. Therefore low temperature particulate removal produces the lowest emissions. Special attention must be given to the submicron particles since they have the greater surface area per gram.

The Canadian pilot plant established by Environment Canada and Flakt Canada showed that flue gas temperature was an important operating variable for achieving high removal efficiency for many of the pollutants measured. Appropriate operating conditions for particulate removal devices (lime scrubber or spray dryer) each followed by a baghouse filter, were identified to obtain extremely high removal efficiencies for dioxins and furans ( > 99%), other trace organics (up to 98%), heavy metals, including mercury, arsenic, lead ( > 99%) and up to 97% for mercury. Excellent removal ( > 95%) was also obtained for acid gases, i.e. HCl and SOx. (Klicius et al 1987).Electrostatic precipitators (ESP) are less efficient than bag filters at removing the smaller particles. Lime treatments also removes acid gases, particularly HCl which otherwise reaches significant levels in incinerator emissions.

Table 2 shows approximate outputs of selected pollutants from incinerators, per tonne of refuse burned, for Ordinary and for modern incinerators with acid gas removal.

TABLE 2

TYPICAL EMISSION FROM MSW INCINERATORS IN GRAMS PER TONNE OF WASTE (adapted from Hansen and Dean 1987)

| | Ordinary | Modern |
|---|---|---|
| Particulates | 600 | 60 |
| HCl | 4200 | 300 |
| SOx | 4000 | 1000 |
| Cd | 2 | 0.0004 |
| Hg | 2 | 0.1 |
| 2378 Dioxin | $60-600 \times 10^{-6}$ | $0.6-10 \times 10^{-6}$ |

Dioxins adsorbed on fly ash (very little is found on bottom ash) represent a possible environmental risk if they can be leached into ground water. Swedish studies show negligible extraction by melted snow so that little risk is associated with the use of fly ash for road construction. Other studies have shown that dioxins can be extracted by water containing organic substances such as might occur in landfill leachate. Whether the added risk of dioxins is comperable with risks from other pollutants in the leachate has not been determined. Some districts prohibit the disposal of fly ash in landfills and treat it as a hazardous waste. In West Germany, however, the dioxin content of collected fly ash is usually below the level that would limit its transport according to Federal regulations.

## 3.2 Measurement and interpretation

The polychlorinated dibenzo-p-dioxins (PCDD) and the closely related dibenzofurans (PCDD) exist as a large number of isomers that are difficult and expensive to analyse. A single analysis of flue gas emissions costs $1200 to $1500 and is reproducable only to about a factor of two under good operating conditions. In order to get reliable measurements it is necessary to use radioactive tracers for the different isomers and correct the measurements for losses in handling. These losses can be as great as 75% and still be acceptable. (Rappe 1987b).The recommended Nordic methodology for Dioxin analysis was presented by Jansson and Bergvall (1987).

The 75 chlorinated dioxin isomers and the 135 corresponding furane isomers vary greatly in toxicity. Most work has been done on the 2378 tetrachloro dioxin which is the most toxic of the isomers and the only one on which there is evidence regarding carcinogenicity. Many different schemes have been developed to express the toxicity of an observed mixture of isomers in terms of dioxin equivalents, which is the concentration of 2378 that would have the same toxicity as the mixture. For most mixtures studied the various equivalents agree as closely as replicate analyses. (Ahlborg and Victorin 1987, Mukerjee and Cleverly 1987).Acute toxicity to 2378 dioxin varies by a factor of nearly 10000 between different test animals. Evidence from accidents suggests that man is one of the least sensitive species with chloracne being the only significant effect of dioxin poisoning. Safety levels are set based on the most sensitive species with arbitrary additional safety factors such as 200 (Denmark) or 1000 (West Germany).

## 3.3 Destruction and formation

Dioxins are destroyed in the hot flames of a good incinerator operating at the CO minimum, this corresponds to the least excess $O_2$ that avoids puffs of gas that have insufficient oxygen for combustion (starved air conditions). Obviously the design of the grate and the air intakes contributes markedly to the actual combustion conditions as does the moisture content and composition of the waste. Thus CO appears to be the most useful single measure of furnace performance although $O_2$ or temperature can be used under reasonably steady conditions.(Bergstrom and Warman 1987,Hagenmaier et al 1987, Hasselriis 1987).

Dioxins can, however, be synthesized on fly ash particles in flue gas at temperatures near 300°C. This occurs on ash deposits on condensor surfaces and in the filters of sampling equipment. How much it contributes to emissions that pass out the stack is at present unknown. (Vogg et al 1987).There is no evidence that organic chlorine, such as PVC, is the only source of chlorine for synthesis of dioxin. Rather total chlorides from all sources, including table salt, contribute via HCl and $Cl_2$ (formed by the Deacon process) to chlorinate aromatic nuclei producing the various dioxin isomers. One ton of waste contains some 6 kg of chlorine most of which comes off as HCl. Dioxin production is measured in micrograms per ton of waste burned, ie one ppb of the chlorine turns up in dioxins.

## 3.4 Other sources

Early studies on fly ash recovered from ESP or filter bags showed measurable dioxins. At that time it was assumed that this represented dioxin emissions because reliable analyses of stack emissions for dioxins were not possible. It was further assumed that municipal incinerators were the principal source of dioxins in the environment. Emissions were of the order of 6 mg per tonne of refuse. However, ordinary control of particulates, usually by ESP, reduced this to between 0.6 and 0.06 mg/tonne, ie by one to two orders of magnitude and wet scrubbers are capable of going down a further order of magnitude. With these reductions other sources of dioxins must be examined.

Among other sources unrelated to combustion are impurities in pesticides. The weed killers,especially 245 T, were implicated as the source of dioxins in South Vietnam (Commoner et al 1987). Pentachlorophenol is a ubiquitous pesticide used at high levels to control mold and moths and worms in woolen, leather and wood products. According to Hagenmaier et al (1987) dioxins in house dust can be attributed to the use of pentachlorophenol as a preservative. The levels are higher than one would get from emissions from a good incinerator.

Another source is from the use of chlorine to bleach paper and cotton. Samples of sediment from waters that receive effluents from paper mills, and crabs from these waters showed high levels of toxic dioxins. Only a few measurements of these sources have been made (Rappe et al 1987a).

Automobile exhausts have also been implicated as a possible source of dioxins but until more data has been collected it is not possible to say whether they have a significant influence on the dioxin equivalents in the environment. One problem is that bromine, used in the form of ethyl bromide as an additive with tetraethyl lead in gasoline may make brominated dioxin isomers and we know almost nothing about their toxicity (Commoner et al 1987).

## 3.5 National policies regarding dioxin emissions

Proposals for the control of dioxins vary widely from "Ban Incinerators" defended at our seminar by Barry Commoner (1987), to the English policy of "best practicable means". Sweden became alarmed when their policy to incinerate all urban wastes faced the dioxin emissions data. They issued a temporary ban on incinerator construction and mounted intensive studies of dioxin control. The results of these studies and related work in Germany, the USA and Canada formed the heart of our seminar to which were added numerous studies from other countries. The immediate result of the Swedish study was to lift the ban on incinerator construction, only 16 months after it had been imposed. Sweden imposed special limits on emissions of HCl (100 mg $m^{-3}$) Hg (0.08 mg $m^{-3}$) Particulate matter (20 mg $m^{-3}$) and dioxins (0,5-2.0 ng $m^{-3}$).The dioxins (PCDD+PCDF) are calculated as Eadon equivalents which means that a nearly complete isotopic analysis is required for each sample.The limits given are monthly averages under normal working conditions and are regarded as trial guidelines subject to revision after a couple of years of experience (Bergvall 1987).

The Swedish guidelines are to some extent an idealistic response to a complicated problem. Because of the large uncertainty in any single dioxin analysis it is necessary to make many repeated tests to have assurance that emissions are within the guidelines. These tests are expensive and may well be devoted to one of the minor sources of dioxins in the environment. Meanwhile, if the particulates are controlled, most of the dioxin, which will be adsorbed on the fly ash, will be caught. If HCl is removed by wet neutralization even more fly ash will be removed. If mercury is captured the collector will be cool enough to inhibit dioxin reformation. Analyses for HCl and particulates are routine and inexpensive. Mercury will be caught if wet or semi-wet, cool processes are used to catch HCl. Analysis for Hg is more expensive than for HCl but far less than for dioxins.

Controls set in other countries differ widely.West Germany, relying on much the same sort of data as Sweden, set rather different standards in their TA Luft 1986 (Technical Instructions for Maintaining Air Quality). They recommend furnace conditions in terms of temperature and $O_2$ sufficient to destroy chlorinated organics and they set upper limits on HCl (50.all units in mg $m^{-3}$), $SO_2$ (100), NOx (500), CO (100), Organic Carbon (20) and particulate matter (30).There are also limits on HF (2) and on groups of metals, ie Hg+Cd (0.2). Notably absent is any specific limit on dioxins because state of the art incinerators do not cause a significant risk from dioxin emissions. Since it is not possible to measure dioxins continuously limit values for monitoring would not be practicable. Representative sampling would be too expensive to be justified by the low level of risk involved (Barniske 1987).

Methods for evaluating the risk from dioxins were presented both by Ahlborg and Victorin in Sweden (1987) and Mukerjee and Cleverly (1987) for the US EPA. While formally different the two approaches end up with similar calculated risks. Because these calculated risks include statistical uncertainties and arbitrary safety factors, there is no point in comparing them. What is important is that while uncontrolled incineration may have caused an unacceptable health risk from dioxins the emissions from well operated modern incinerators are so low that they will make a negligible contribution to the overall health problem. Reduction of acid gases and particulates will probably do far more good in reducing health risks than can possibly be ascribed to the accompanying reduction in dioxins.

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# AIR EMISSIONS TESTING AT THE WURZBURG, WEST GERMANY ENERGY FROM WASTE FACILITY

Ogden Martin Systems Inc.

R. Essinger

Paper unavailable at time of printing

# THE NATIONAL INCINERATOR TESTING & EVALUATION PROGRAM (NITEP)
# MASS BURNING TECHNOLOGY ASSESSMENT

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9th Canadian Conference on Waste Management
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## INTRODUCTION

This paper focusses mainly on the important modifications and the extensive combustion test program recently completed on a state-of-the-art mass-burning incinerator located in Quebec City, burning municipal solid waste.

Today's modern industrialized society is a generator of substantial quantities of municipal solid waste (MSW). Conservative estimates put per capita generation at about 1.8 kg per day or approximately 16 million tonnes per year for all of Canada, most of which ends up in landfills. The increasing cost and complexity of landfilling MSW, combined with the difficulties of locating new sites, have forced municipalities to seriously consider alternatives such as incineration in energy-from-waste, (EFW), facilities. Incineration reduces the volume of waste to be landfilled by up to 90%, extending the life of existing sites and reducing the need for new ones. These facilities also offer the option of generating revenue through energy production.

One question that is raised repeatedly with both existing and proposed EFW facilities is how safe are the emissions produced. Many synthetic and toxic chemicals, ingredients which support contemporary lifestyles, end up in the waste as used or unwanted consumer products. Uncontrolled burning of these products and their packaging can release emissions of toxic trace organics and heavy metals.

Addressing these issues and many others is the objective of the multi-faceted National Incinerator Testing and Evaluation Program (NITEP). The five-year program is mandated: to identify energy-from-waste technologies in Canada, to assess relationships among state-of-the-art designs, operations, energy benefits and emissions; to examine effectivness of emission control systems and to provide input to National Guidelines for Emissions. To date, the combustion assessment component of the program has successfully completed work on a modular two-stage design in Prince Edward Island (PEI), on two different types of air pollution control systems in Quebec City, and on mass burning technology which is the subject of this report.

## BACKGROUND

The Quebec Urban Community Municipal Solid Waste Incinerator Plant is a mass-burning design developed in the early 1970's to burn as-received refuse (i.e. without any preparation) in a water-wall furnace. The plant produces steam using flue gas heat recovery boilers. The incinerator plant is owned by the Quebec Urban Community (QUC) and is located in an industrial area of Quebec City, adjacent to residential and commercial zones. It receives municipal and commercial solid waste collected by the QUC, as well as from several other municipalities and private contractors. All of the steam generated by the plant's four incinerator units is sold to a local paper company.

The incinerator plant employs the technology developed in Europe and represented a contemporary design when built in 1974. Throughout the years, a number of design changes were made to improve the operational problems in the plant, such as furnace slagging and emissions of large unburned material. However, some of the design changes compounded existing emission problems.

## PLANT OPERATION

The principle elements of the Quebec Urban Community municipal waste incineration plant are shown in Figures 1 and 2, and include a refuse storage pit and crane system, four incinerators/boilers, each rated at 227 tonnes per day, electrostatic precipitators, ash quenching systems with storage pit and crane, and a common stack. Each incinerator consists of a vibrating feeder-hopper, feed chute, drying/burning/burn-out grates, refractory-lined lower burning zone, waterwalled partially-lined upper burning zone chamber, a vertical tube mechanically-rapped waste heat recovery boiler with superheater and economizer, a two-stage electrostatic precipitator, an induced draft fan, and a wet ash quench/removal system.

## DESIGN MODERNIZATION

In May 1985, a comprehensive study was completed under NITEP on the modernization of the Quebec incinerators. The study detailed the many changes that would be required to transform the incinerators into a "state-of-the-art" mass burning design and to reduce the existing emission problems. Based on the study findings, the CUQ decided to experiment by upgrading one of the incinerator units to assess the impact of the proposed changes before modifications were made to all the units.

To ensure that the most appropriate furnace configuration was developed; a one-sixth scale, three-dimensional flow model of the furnace was fabricated of wood and plexiglass. Through the plexiglass panels, trained observers were able to visually assess the mixing pattern of the various furnace configurations being investigated. Sawdust and air were used to simulate a number of combustion conditions. In addition, video tapes were made of the model studies to allow for a more detailed assessment at a later date. In all, 52 different conditions were run which looked at:

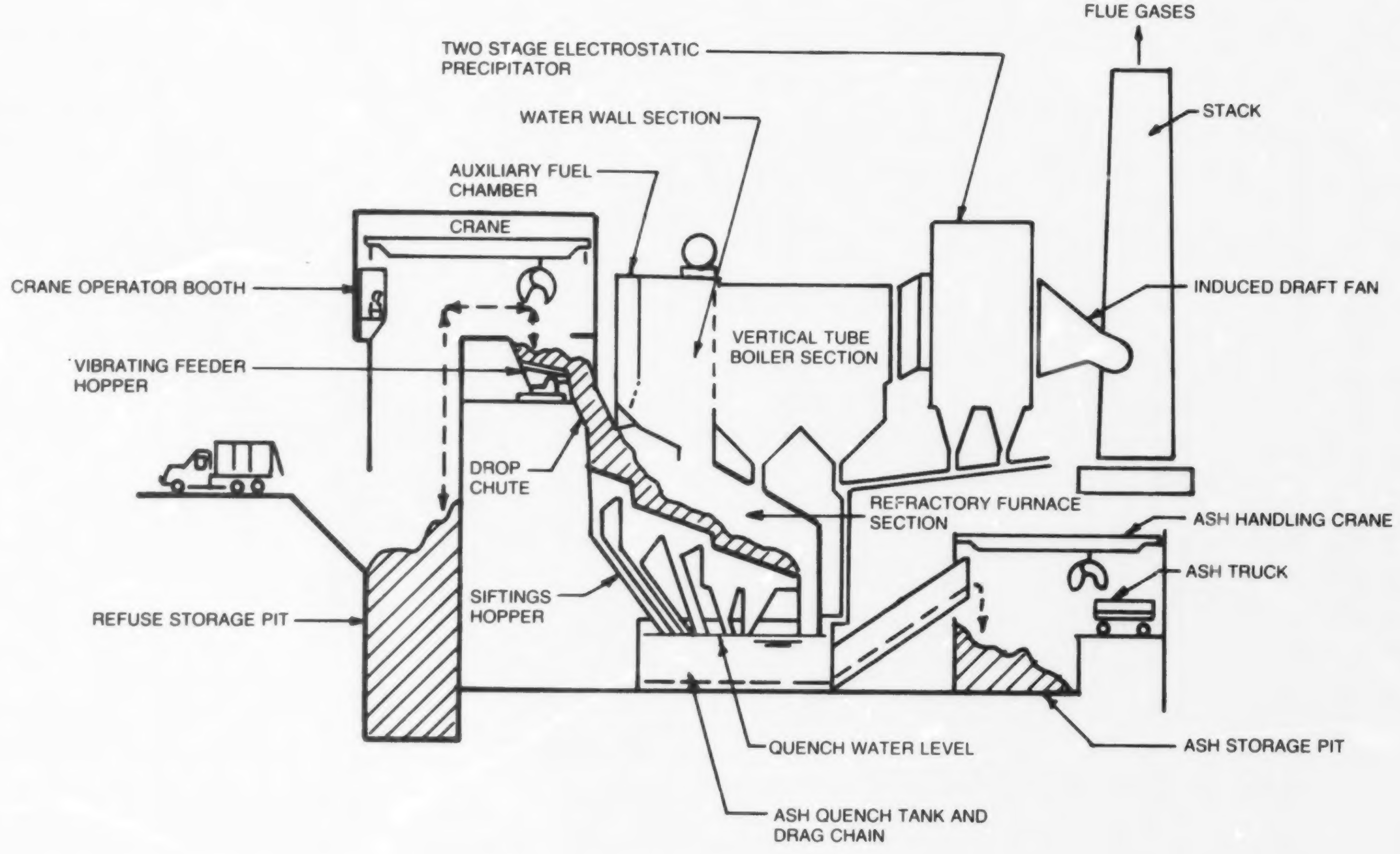
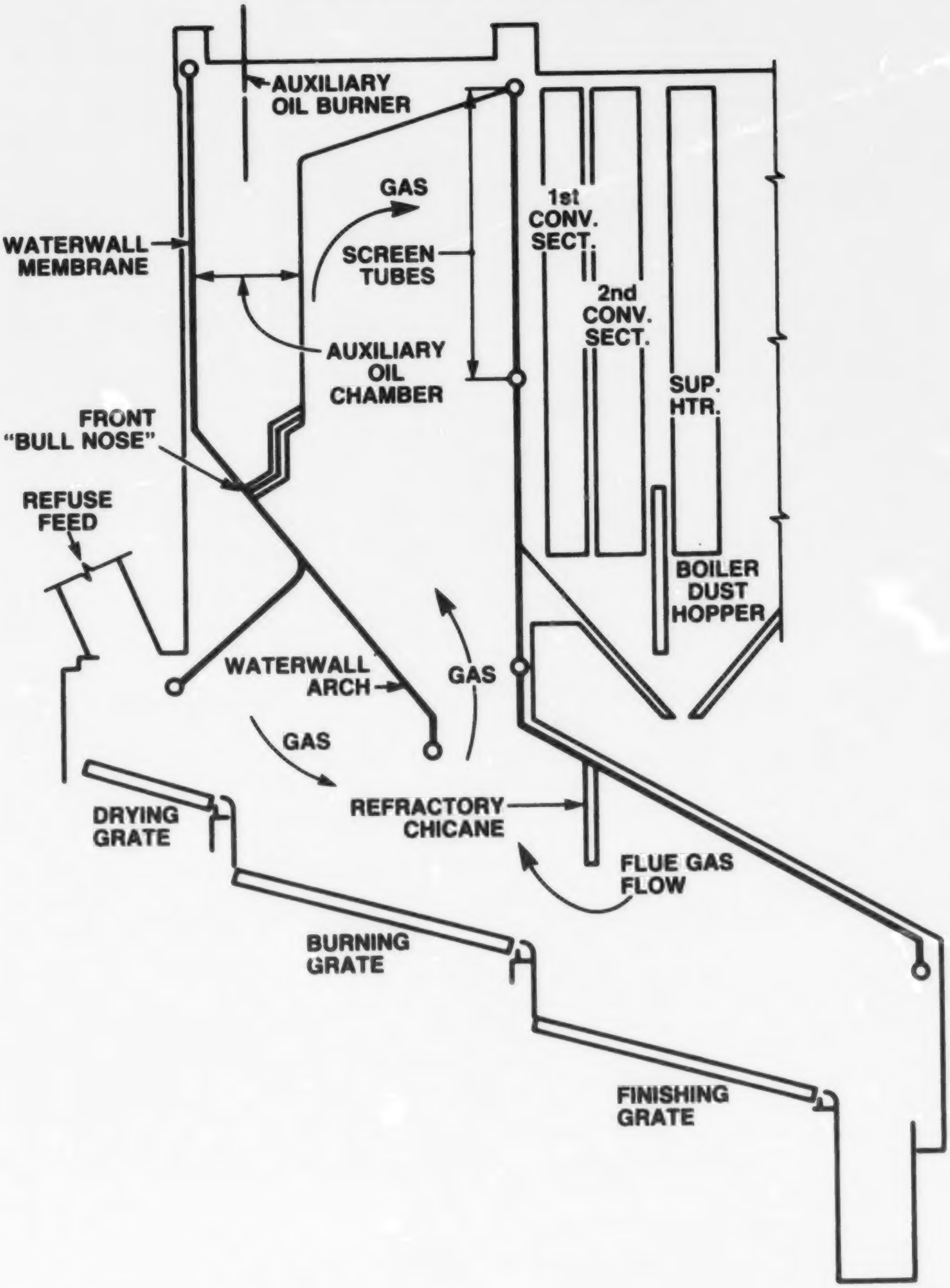

FLUE GASES
TWO STAGE ELECTROSTATIC PRECIPITATOR
STACK
WATER WALL SECTION
AUXILIARY FUEL CHAMBER
CRANE
CRANE OPERATOR BOOTH
INDUCED DRAFT FAN
VERTICAL TUBE BOILER SECTION
VIBRATING FEEDER HOPPER
DROP CHUTE
REFRACTORY FURNACE SECTION
ASH HANDLING CRANE
ASH TRUCK
SIFTINGS HOPPER
REFUSE STORAGE PIT
QUENCH WATER LEVEL
ASH STORAGE PIT
ASH QUENCH TANK AND DRAG CHAIN

FIGURE 1
QUEBEC INCINERATOR
SCHEMATIC CROSS-SECTION

# Figure 2
# QUEBEC INCINERATOR ORIGINAL DESIGN


AUXILIARY OIL BURNER
GAS
1st CONV. SECT.
WATERWALL MEMBRANE
SCREEN TUBES
2nd CONV. SECT.
AUXILIARY OIL CHAMBER
SUP. HTR.
FRONT "BULL NOSE"
REFUSE FEED
BOILER DUST HOPPER
WATERWALL ARCH
GAS
GAS
DRYING GRATE
REFRACTORY CHICANE
FLUE GAS FLOW
BURNING GRATE
FINISHING GRATE

a) the original furnace design (see figure 2)
b) a partially modified design
c) a completely new furnace design.

Based on a thorough assessment of the various conditions investigated, a final furnace design configuration was selected which provided the highest degree of turbulence and mixing, both of which are necessary for good combustion. (See figure 3.) As part of the incinerator modifications, the following important design considerations were addressed: a) an improved primary air distribution system was installed; b) the nozzle design and location of the secondary air system were selected, c) the configuration and positioning of the front and rear furnace "bull noses" were determined to optimize mixing, d) combustion gas residence time was increased 30% by enlarging the upper furnace chamber.

Combustion air is provided to the furnace at two locations, under the grates (primary air) and above the grates (secondary air). The primary air is drawn from the refuse pit area and is modulated continuously by multi-blade dampers on the primary air fan. Primary air on the modified unit is distributed to 9 zones located beneath the grates, each fitted with individual motorized and flow-controlled dampers.

Primary air supplied to the downstream end of the drying grate provides the necessary combustion air required for early ignition of the refuse.

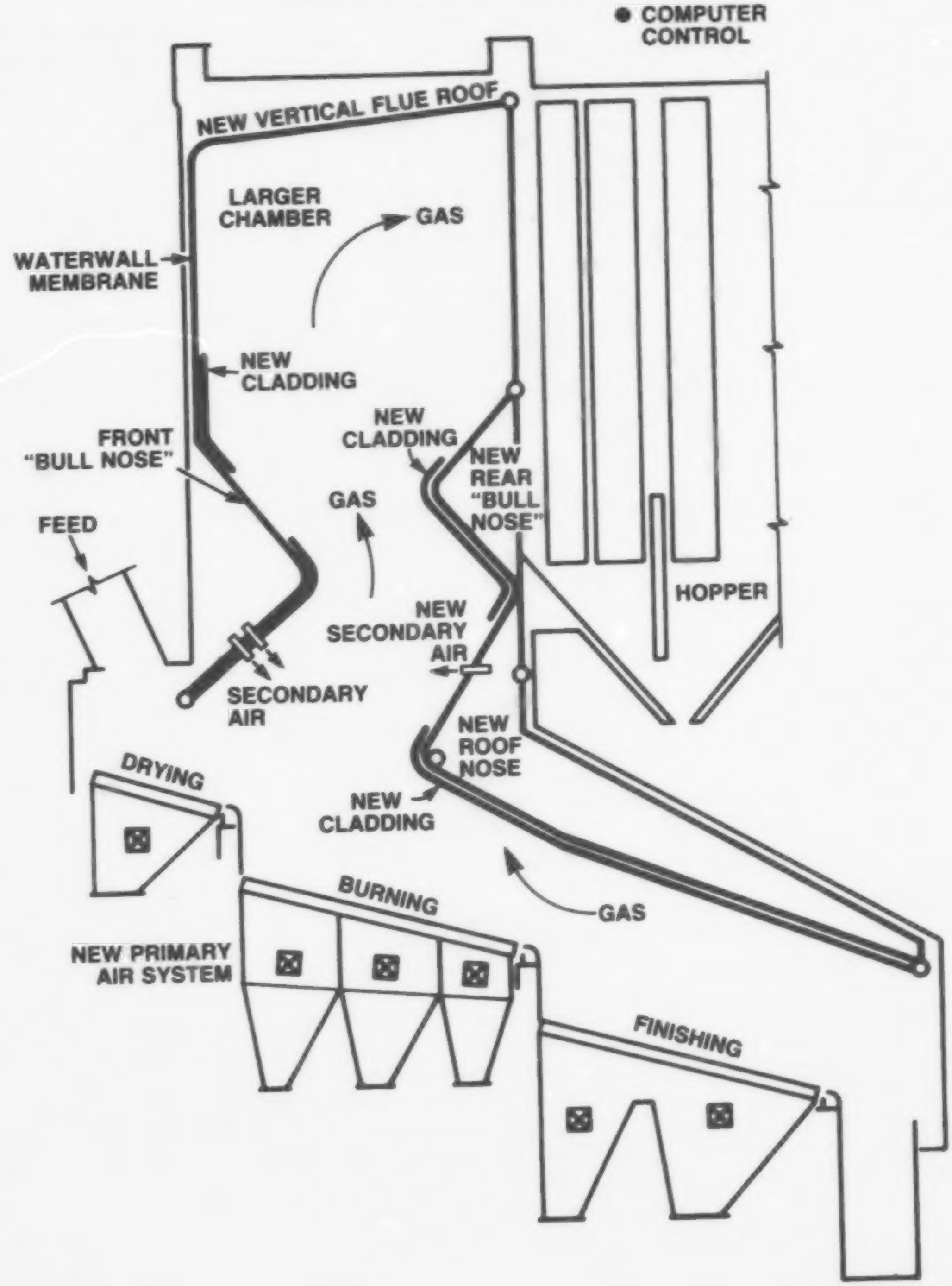
Air to the burning grate is distributed into 6 hopper zones of approximately the same size. Each of the hopper zones can automatically control air flows and pressures, through separate ducts from the primary air header. This feature prevents excessive amounts of combustion air from bypassing the large refuse piles on the grate and reduces carryover of fine material from sections of the grate where the piles are smaller.

The finishing grate air is supplied through two hopper zones with individual dampers and ensures that all the refuse is burned prior to discharging into the ash pit.

Secondary air is introduced into the furnace radiation chamber by one series of nozzles at the front "bull nose" and another series at the rear "bull nose". Air for these nozzles is also drawn from the refuse storage pit area by a fan.

The nozzles have individual manual dampers for control purposes and to ensure that all provide equal flows. To achieve the required air distribution between the front and rear nozzles, a control damper is employed to adjust the distribution. Good control of air flows through these nozzles is important since they are used to reduce flue gas temperatures and maintain the desired excess air level, while achieving sufficient mixing for completing combustion.

# Figure 3
# QUEBEC INCINERATOR MODIFIED DESIGN


● COMPUTER CONTROL
NEW VERTICAL FLUE ROOF
LARGER CHAMBER
GAS
WATERWALL MEMBRANE
NEW CLADDING
FRONT "BULL NOSE"
NEW CLADDING
NEW REAR "BULL NOSE"
GAS
FEED
HOPPER
NEW SECONDARY AIR
SECONDARY AIR
NEW ROOF NOSE
DRYING
NEW CLADDING
BURNING
GAS
NEW PRIMARY AIR SYSTEM
FINISHING

The concept of the "bull nose" configuration shown is essential to ensure that low upper flue gas velocities are maintained and that good mixing of combustion gases with overfire air in the lower portion of the furnace chamber as well as to improve gas distribution into the boiler.

In addition, the shape of the "bull noses" addressed factors such as the directional flow of the flue gas in the furnace and provided an excellent zone where overfire or secondary air could be strategically located. The final "bull nose" configurations and overfire air jet location were primarily based on the air flow modelling previously discussed.

In order to bring the test incinerator (Unit 4) up to the "state-of-the-art" in automatic controls, the existing system was replaced by a computer control system which displays and controls all process aspects. The new control system included some of the following functions:

1. Grate speed control system.
2. Steam flow control.
3. Automatic air flow control of the primary air distribution system.
4. Secondary air supply control system.

All the upgrading was completed by March 1986 and commissioning trials began in early April 1986.

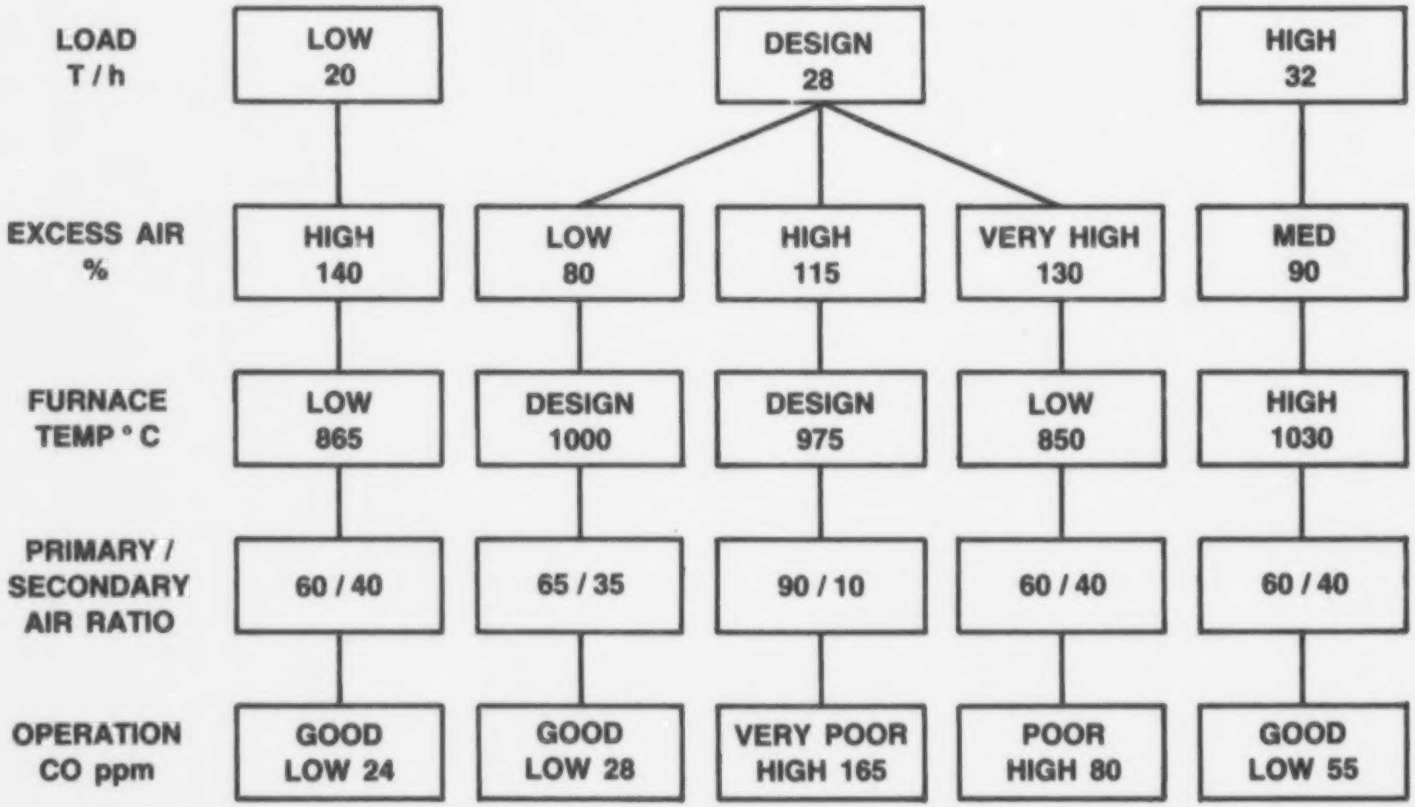
## COMBUSTION TEST PROGRAM

An extensive combustion test program was established to evaluate the performance and effectiveness of the new furnace design. The objective of this program was to develop correlations between various operating parameters and emissions over a wide range of operating conditions.

Two levels of testing were involved in the combustion test program: characterization and performance. The characterization tests served as a basis for developing an understanding of the incinerator operating range, debugging of all systems, facility logistics and field crew familiarization.

To thoroughly asssess operating conditions, items such as refuse feed rate, steam rate, excess air levels, distribution of overfire and undergrate air, and temperature profiles were recorded for each test. Both poor and good operating practices were included under low, normal and high steam loads. In all, 22 characterization tests under 18 different operating conditions were conducted. Upon a thorough assessment of the characterization test results, five performance test conditions were selected, as shown in figure 4. These latter tests involved extensive sampling and analysis, process and data evaluation.

Figure 4
PERFORMANCE TEST
CONDITIONS


LOAD T / h
LOW 20
DESIGN 28
HIGH 32
EXCESS AIR %
HIGH 140
LOW 80
HIGH 115
VERY HIGH 130
MED 90
FURNACE TEMP ° C
LOW 865
DESIGN 1000
DESIGN 975
LOW 850
HIGH 1030
PRIMARY / SECONDARY AIR RATIO
60 / 40
65 / 35
90 / 10
60 / 40
60 / 40
OPERATION CO ppm
GOOD LOW 24
GOOD LOW 28
VERY POOR HIGH 165
POOR HIGH 80
GOOD LOW 55

NITEP - QUEBEC

To characterize input and output, all incoming refuse and all the ashes collected were weighed and representative samples analyzed. Each sample was analyzed for two groups of compounds: organics, which consisted of dioxins, furans, chlorobenzene (CB), polychlorinated biphenyls (PCB), polycyclic aromatic hydrocarbons (PAH), and chlorophenols (CP); and metals, consisting of cadmium (Cd), lead (Pb), mercury (Hg) and twenty-seven others. In addition, the combustion gases leaving the stack were sampled for the compounds listed above, as well as for acid gases, such as hydrogen chloride (HCl), sulphur dioxide ($SO_2$) and nitrogen oxides ($NO_x$); and conventional products of combustion, such as carbon monoxide (CO), carbon dioxide ($CO_2$), oxygen ($O_2$) and total hydrocarbons (THC). In all, almost one thousand samples were analyzed for organics and a comparable number for inorganics.

The quantity of data generated on and off site was staggering. Almost 8 mega bytes of information were collected during each test, covering process operations, continuous gas monitoring and various temperatures throughout the system every twenty seconds. This required the development of a relatively portable and somewhat powerful computer-based data logging system. The system was also required to organize and analyze all the information collected from the data loggers as well as those from the field data sheets. A micro-computer based system was developed and employed which could store and analyze all the data collected during each test day.

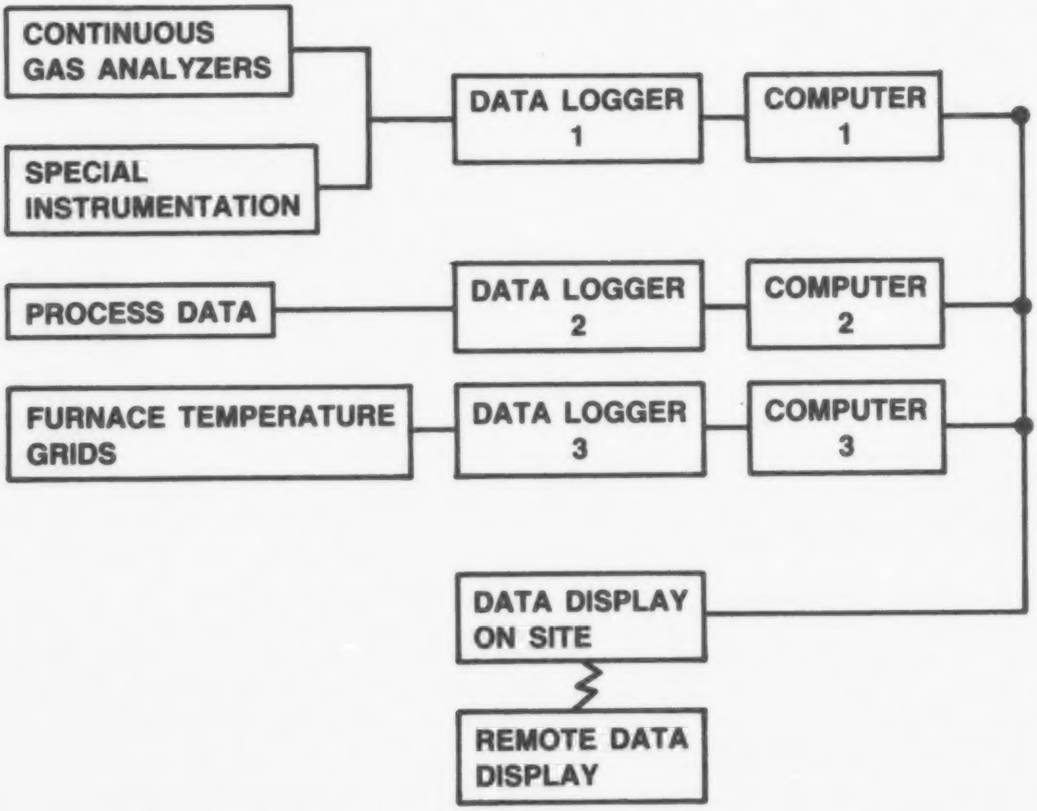
Three separate micro-computer-based systems, linked into a network, were chosen for this task (see figure 5). The first system was used to collect continuous gas data from the combustion exhaust gases. The second system collected and analyzed incinerator process data, while the third system collected readings from two temperature thermocouple grids installed in the radiation chamber zones of the furnace.

Each of the computer systems provided a "real time" graphic and statistical analysis of selected logged data. This provided on-the-spot monitoring of the progress of the tests to enable project managers to make decisions quickly. In addition, plots of concentrations, temperatures and process data versus time were displayed on the computer screen on an hourly interval to observe trends.

Upon completion of each test day, the data generated was processed by a second crew overnight to verify and correct all data, to reduce the data and produce detailed tables, summaries and graphics for the Field Test Report. This provided the field project manager the opportunity to review the results to assess the adequacy of the test and to evaluate it against previous tests.

Although much of the groundwork was broken in planning and field testing for PEI, particularly in terms of the selection of basic methods and protocols, the test program in Quebec City departed from the first with respect to:

# Figure 5
# DATA ACQUISITION SYSTEM


CONTINUOUS GAS ANALYZERS
SPECIAL INSTRUMENTATION
PROCESS DATA
FURNACE TEMPERATURE GRIDS
DATA LOGGER 1
DATA LOGGER 2
DATA LOGGER 3
COMPUTER 1
COMPUTER 2
COMPUTER 3
DATA DISPLAY ON SITE
REMOTE DATA DISPLAY

NITEP - QUEBEC

a) the furnace design modifications undertaken to modernize and to significantly improve the combustion capability and control of the incinerator (discussed previously).

b) the "real time" data reduction in the field.

c) the overall scope and extent of sample collection and analyses.

Of significant importance to the Quebec City program, was the extensive amount of test data available on the old furnace design. The CUQ incinerator has been the subject of acceptance testing, annual testing for particulates, particulate sizing characterization, and testing for HCl and metals emissions, as well as dioxin and furan emissions, all as part of a provincial assessment program and previous NITEP testing at this facility. All this information has provided an excellent reference to the comparison and assessment of the improvements made to the furnace design.

## PRELIMINARY FINDINGS

In 1984, Environment Quebec undertook an assessment of the dioxin and furan emissions from the Quebec Urban Community incinerator plant. Three tests were completed, which indicated relatively high concentrations of dioxins and furans, which is not uncommon for facilities of this vintage. However, after implementing the modifications as previously discussed, a significant reduction in dioxin emissions was observed (see figure 6). By employing good operating practices as defined in modern incinerator facilities, dioxin concentrations were reduced between 40 and 100 times below the 1984 test results. Furthermore, under poor operating practices, the reduction achieved was an order of magnitude. This suggests that the new design had a significant influence on dioxin emissions; however, good operating practice was also essential to minimize dioxin formation and emission.

Another interesting finding was the large reduction in particulate emissions between the old and new furnace designs. In figure 7, the particulate concentrations at the stack are compared between the old and new designs at 28 and 32 tonnes/hr. steam flow. On the average, reductions in excess of 20 times were achieved with the new design concept at both of these steam rates. The degree of reduction in both dioxins and particulate was approximately the same which suggests a possible interrelationship. Based on current theory that dioxins are mostly bound to particulates in the combustion gases, it is postulated that good combustion conditions that reduce the carryover of particulates from the furnace, will also minimize the formation and emission of dioxins into the environment.

The aforementioned findings are but a few that were observed from the test results. At the time this paper was prepared, not all the analytical results were available. Consequently, the correlation on much of the data could not be completed. This information, as well as other significant findings, will be given during the conference presentation. A comprehensive series of reports on the mass-burn test program will be published during the fall of 1987.

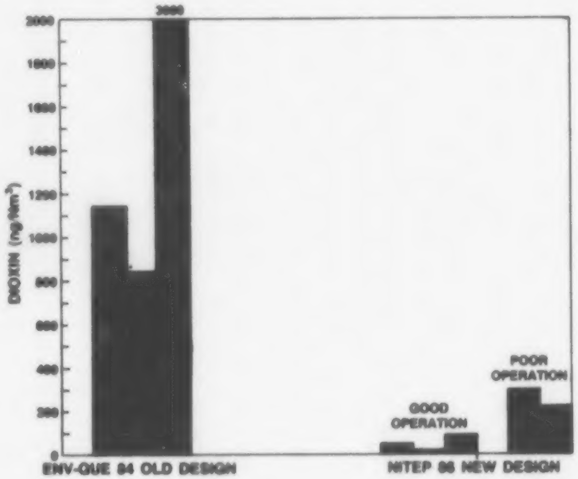


FIGURE 6 - DIOXIN EMISSION COMPARISON

NITEP-QUEBEC

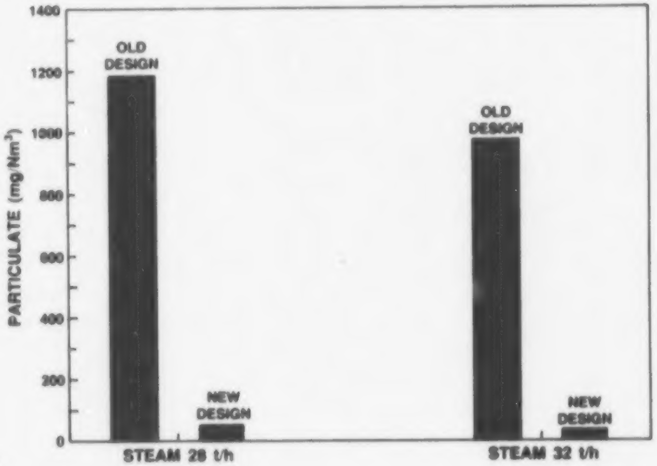


FIGURE 7 - PARTICULATE EMISSION COMPARISON

NITEP-QUEBEC

# THE INORGANIC CHARACTERISTICS OF SLUDGES ASSOCIATED WITH NATURAL GAS PROCESSING

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## INTRODUCTION

In 1985 the Canadian Petroleum Association (CPA) commissioned a pilot study of procedures for the sampling and analysis of sludges from natural gas processing plants. Monenco Consultants (Calgary) delivered triplicate samples of three sludges in November 1985 to Norwest Labs (identified below as NWL) for analysis of a range of mostly inorganic parameters; analysis for organic chemicals, and toxicity tests were also part of the study but are not considered here. A sample of each sludge was also sent for quality control (QC) purposes to a second laboratory (identified below as QCL). Details of the analytical requirements and procedures were also provided and are summarized in Figure 1. As a further exercise in QC, the two labs were later sent four soil samples, for metals analysis by nitric/perchloric acid digestion.

### Sludge and soil materials

The sludges were identified as a sulphur block drainage pond sludge, an amine leaf filter sludge and a main process wastewater pond sludge; no other details were provided to the laboratories. The soils (unknown to the labs) were Canmet standards SO-1, 2, 3 & 4.

## MAIN STUDY

Full details of analytical results are given in the Final Report prepared by Monenco Consultants Ltd. (1987).

### Results of analyzing sludges

A summary of the essentials of the initial sets of results obtained by NWL and QCL is given in Table 1. In all Tables in this paper, unless otherwise stated, results are means of replicates that differ by less than 10% of the mean. Some apparently glaring discrepancies between the two sets of results were in fact compatible, the superficial difference being

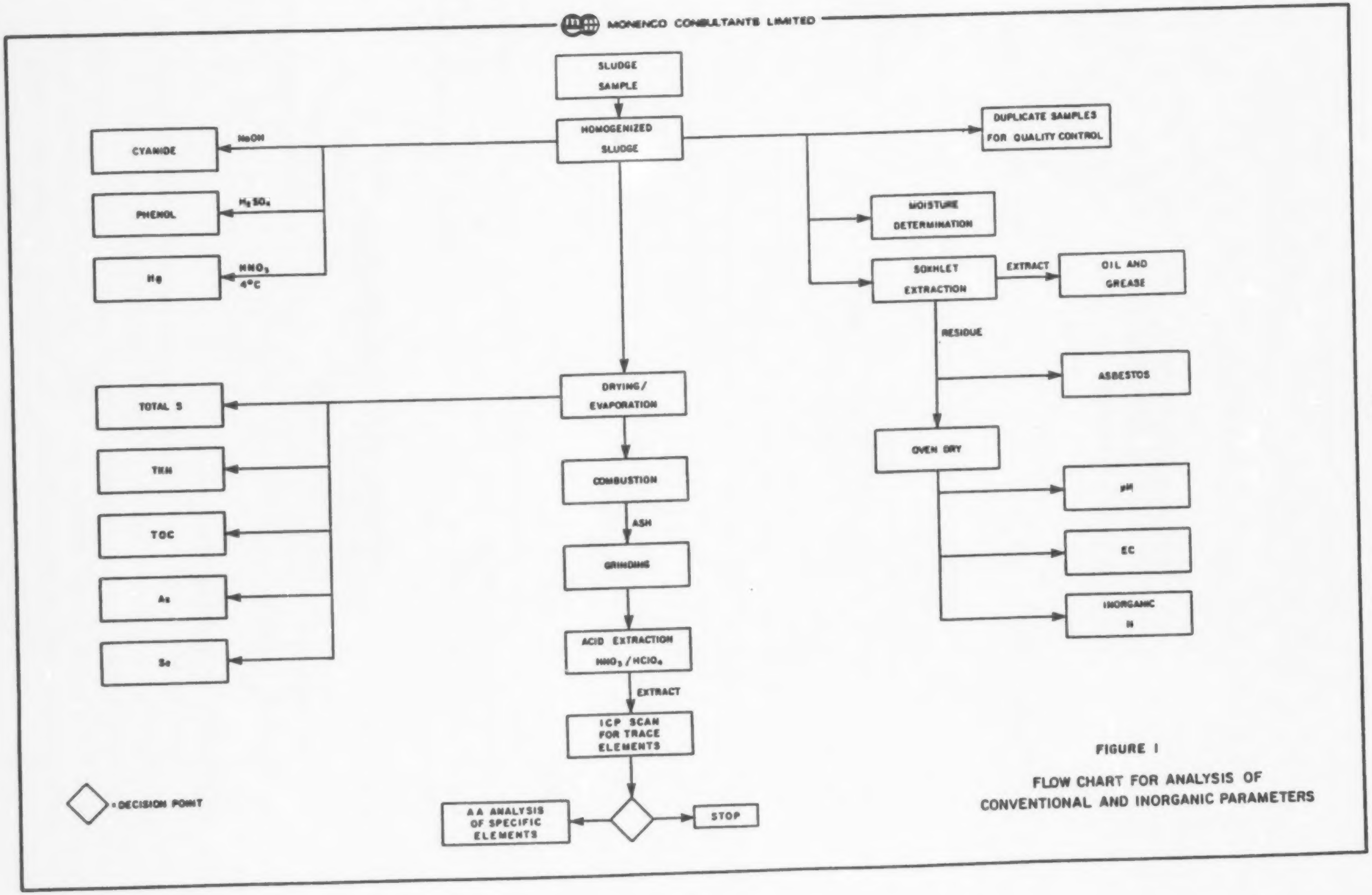
MONENCO CONSULTANTS LIMITED
SLUDGE SAMPLE
HOMOGENIZED SLUDGE
DUPLICATE SAMPLES FOR QUALITY CONTROL
CYANIDE
NaOH
PHENOL
$H_2SO_4$
Hg
$HNO_3$
4°C
MOISTURE DETERMINATION
SOXHLET EXTRACTION
EXTRACT
OIL AND GREASE
RESIDUE
ASBESTOS
OVEN DRY
pH
EC
INORGANIC N
DRYING/ EVAPORATION
TOTAL S
TKN
TOC
As
Se
COMBUSTION
ASH
GRINDING
ACID EXTRACTION $HNO_3/HClO_4$
EXTRACT
ICP SCAN FOR TRACE ELEMENTS
AA ANALYSIS OF SPECIFIC ELEMENTS
STOP
= DECISION POINT

FIGURE I

FLOW CHART FOR ANALYSIS OF CONVENTIONAL AND INORGANIC PARAMETERS

# TABLE 1. COMPARISON OF AVERAGE RESULTS FROM NWL WITH RESULTS FROM QCL (1)

| Parameter | Units | Sulphur Block Drainage Pond Sludge | | Amine System Leaf Filter Sludge | | Main Process Wastewater Pond Sludge | |
|---|---|---|---|---|---|---|---|
| | | NWL | QCL | NWL | QCL | NWL | QCL |
| Loss on drying[2] | % | 44.8 | 38.2 | 64.3 | (3) | 52.4 | 42.4 |
| pH | - | 3.0 | 3.47 | 10.6 | 5.44[4] | 8.0 | 8.33 |
| EC | mS/cm | 6.0 | 2.1 | 5.9 | 0.25[4] | 20 | 4.9 |
| Oil and Grease | % | 0.88 | 0.82 | 28 | 42.9 | 1.9 | 2.10 |
| Total Carbon | % | 1.7 | 2.09 | 12 | (3) | 2.2 | 5.14 |
| Total Sulphur | % | 0.66 | 1.23 | 0.21 | (3) | 0.35 | 0.75 |
| Cyanide | ug/g | 17 | 2.81 | 22 | 2.85 | 14 | 5.42 |
| Phenols | ug/g | LT0.2 | 3.17 | 1.4 | 5.81 | 0.3 | 9.60 |
| Total Nitrogen | ug/g | 1660 | 1770 | 5000 | 4943 | 950 | 1450 |
| Ammonia - N | ug/g | 30 | 58 | 140 | 60.6 | 50 | 274 |
| Nitrate - N | ug/g | 0.5 | LT0.01[4] | 160 | 0.46 | 1.2 | 0.19[4] |
| Nitrite - N | ug/g | (5) | LT0.01[4] | (5) | LT0.01 | (5) | 0.06[4] |
| Mercury | ug/g | 0.081 | 0.005 | 0.06 | LT0.005 | 0.17 | 0.065 |
| Cadmium | ug/g | 0.33 | LT0.5 | LT1 | LT1 | 0.60 | 0.49 |
| Chromium | ug/g | 64 | 43.7 | 12 | 4.32 | 190 | 181 |
| Lead | ug/g | 14 | 8.56 | 4.3 | 0.96 | 17 | 11.0 |
| Nickel | ug/g | 8.3 | 8.56 | 4.8 | 7.44 | 14 | 19.3 |
| Zinc | ug/g | 47 | 38.3 | 11 | 4.57 | 170 | 192 |
| Copper | ug/g | 19 | 17.9 | 8.0 | 6.82 | 36 | 43.6 |
| Arsenic | ug/g | 4.6 | 3.63 | 0.71 | 0.78 | 3.9 | 2.93 |
| Selenium | ug/g | LT0.03 | 0.65 | LT0.04 | LT0.05 | 0.05 | LT0.05 |
| Aluminum | ug/g | 17000 | 16700 | 4300 | 121 | 12400 | 15800 |
| Barium | ug/g | 160 | 240 | 6.3 | 2.07 | 170 | 249 |
| Boron | ug/g | 10 | 10.8 | LT2 | LT0.5 | 5.2 | 9.64 |
| Cobalt | ug/g | 2.3 | 4.04 | 0.44 | 1.20 | 4.7 | 7.80 |
| Iron | ug/g | 6600 | 6750 | 2000 | 4451 | 11000 | 15200 |
| Manganese | ug/g | 47 | 52.5 | 28 | 30 | 370 | 519 |
| Molybdenum | ug/g | LT2 | 1.59 | 1.5 | 1.20 | 1.1 | 2.08 |
| Thallium | ug/g | LT50 | 4.53 | LT250 | 0.96 | LT50 | 7.56 |
| Vanadium | ug/g | 39 | 43.0 | 6.7 | 0.82 | 25 | 40.8 |

Notes:

1 all results expressed on an as-received basis
2 oven dried (105°C)
3 inconsistent result, no value reported
4 measured after first drying sample
5 included with nitrate-N

merely due to differing analytical methods at the two labs. For example, the discrepancies in electrical conductivity (EC) for the sulphur block and main process sludges were due to analysis using a 1:2 dried sludge:water extract (QCL) rather than using the saturated paste specified (NWL). The amine filter sludge was mainly monoethanolamine and could not be dried in air; QCL oven dried it and analyzed a 1:2 water extract of the remnant, whereas NWL inserted electrodes into the raw sludge, thereby obtaining completely different results. Later work at NWL was to show that drying this sludge drastically lowered its pH, presumably because monoethanolamine was driven off on drying.

The solid constituents of the stirred amine filter sludge fell out of suspension very rapidly; adding montmorillonite clay failed to soak up the excess monoethanolamine but made the material pasty and more amenable to sub-sampling. Most analyses reported by NWL were done on a clay/sludge paste and the result then corrected for the content of analyte in the clay. The correction involved was small for most analytes, but the mean result for aluminum carried a large error in determination. This result is at first sight very different from that reported by QCL, who prepared a digest of the dried material but, due to the uncertainty in NWL's value, the two results are compatible.

Other discrepancies in the sets of results were not easily rationalized and caused concern. In particular, results for cyanide, phenols and for certain metals, most notably mercury and selenium, were so disparate that follow-up work was undertaken by both labs to try to clear up these differences.

## FOLLOW-UP WORK

A sub-sample of the sulphur block drainage pond sludge (originally sent to QCL) was split at QCL and one replicate sent to NWL. Both labs then analyzed their portions of this material, together with two other standard materials, for the range of parameters listed in Tables 2, 3 & 4. The two standard materials employed were the U.S. Environmental Protection Agency's (EPA) Municipal Digested Sludge (MDS) and Canmet soil standard SO-1. The labs exchanged nitric/perchloric acid digests of the materials and also analyzed them for metals (each lab's digests were therefore analyzed by both labs). Except for arsenic, mercury and selenium measurements, which were analyzed by atomic absorption methods, both labs relied on plasma analyzers for metals (ICP at NWL and DCP at QCL).

## TABLE 2. RESULTS FOR CANMET STANDARD SOIL SO-1.

| | | NWL Data | | QCL Data | | | |
|---|---|---|---|---|---|---|---|
| Parameters | Units | NWL's Digest[1] | QCL's Digest[2] | NWL's Digest[1] | QCL's Digest[2] | Documented Value[3] | ICP Value[4] |
| Mercury | ug/g | 0.03[5] | (6) | (6) | 0.022[5] | 0.022±0.003 | (7) |
| Cadmium | ug/g | LT0.25 | 0.65 | LT0.25 | LT0.25 | 0.15[8] | 7.8 |
| Chromium | ug/g | 150[5] | 96 | 140 | 50 | 160 | 156 |
| Lead | ug/g | 26 | 64 | 15 | 3.8 | 21±4 | 36±6 |
| Nickel | ug/g | 80 | 64 | 100 | 100 | 94 | (7) |
| Zinc | ug/g | 180 | 120 | 160 | 148 | 146 | 130 |
| Copper | ug/g | 74 | 60 | 67 | 68 | 61 | 60 |
| Arsenic | ug/g | 2.3[5] | (6) | 1.7[5] | 0.7[5] | 1.9[8] | 27±4 |
| Selenium | ug/g | 0.03[5] | (6) | (6) | LT0.05[5] | (7) | (7) |
| Aluminum | % | 8.6 | 3.0 | 9.5 | 4.9 | 9.4 | 9.5 |
| Barium | ug/g | 910 | 270 | 930 | 390 | 880 | (7) |
| Boron | ug/g | 5.0 | 16 | 1.5 | 17 | 20[7] | 163±87 |
| Cobalt | ug/g | 26 | 20 | 42 | 38 | 32 | 37 |
| Iron | % | 5.5 | 3.6 | 5.8 | 5.3 | 6.0 | 6.0 |
| Manganese | ug/g | 870 | 600 | 910 | 790 | 890 | 820 |
| Molybdenum | ug/g | LT1.5 | LT0.5 | 4.5 | 3 | 2[8] | 2±1 |
| Vanadium | ug/g | 150 | 69 | 140 | 95 | 139 | 138 |

Notes:

1 Single nitric perchloric digest prepared by NWL, analyzed by NWL and QCL.
2 Single digest made by QCL, analyzed by both labs. Only plasma analyses done on exchanged digests.
3 CANMET recommended value. Range given if more than 10% of mean.
4 ICP results of Spiers et al. (1983). Range given if more than 10% of mean.
5 AA value.
6 Not analyzed.
7 No value available.
8 Uncertified value.

## TABLE 3. RESULTS FOR EPA MUNICIPAL DIGESTED SLUDGE.

| Parameter | Units | NWL Data | | QCL Data | | Recommended Value (Range)[3] |
|---|---|---|---|---|---|---|
| | | NWL's Digest[1] | QCL's Digest[2] | NWL's Digest[2] | QCL's Digest[1] | |
| Ammonia-N | ug/g | 1700 | (4) | (4) | (4) | 1620 (977-2260) |
| Phenols | ug/g | 18 | (4) | (4) | 35 | 29 (0-65) |
| Mercury | ug/g | 11[5] | (4) | (4) | (4) | 16 (0-36) |
| Cadmium | ug/g | 20 | 22 | 20 | 20 | 19 (10-28) |
| Chromium | ug/g | 180[5] | 420 | 240 | 180 | 193 (150-246) |
| Lead | ug/g | 240 | 580 | 260 | 540 | 526 (372-680) |
| Nickel | ug/g | 190 | 200 | 210 | 196 | 194 (164-225) |
| Zinc | ug/g | 1600 | 1600 | 1400 | 1300 | 1320 (1190-1450) |
| Copper | ug/g | 1200 | 1400 | 1100 | 1000 | 1080 (882-1280) |
| Arsenic | ug/g | 5.1[5] | (4) | 4.0[5] | 2.4[5] | 17 (0-89) |
| Selenium | ug/g | LT0.013[5] | (4) | (4) | 2.6±1.4[6] | (7) |
| Aluminum | % | 1.1 | 0.70 | 1.3 | 0.75 | 4.56 (2.01-7.11) |
| Barium | ug/g | 110 | 580 | 170 | 520 | (7) |
| Boron | ug/g | 12 | 330 | 1[2] | (4) | (7) |
| Cobalt | ug/g | 8.5 | 9.6 | 12 | 8.0 | (7) |
| Iron | % | 1.6 | 1.8 | 1.8 | 1.7 | 1.65 (1.12-2.17) |
| Manganese | ug/g | 220 | 240 | 240 | 220 | 202 (182-223) |
| Molybdenum | ug/g | 3.5 | 4.0 | 5.0 | LT3 | (7) |
| Vanadium | ug/g | 27 | 19 | 26 | 15 | 13 (1.7-24.14) |

Notes:

1 Single digest analyzed.
2 Only plasma analysis done on exchanged digests, except as by QCL.
3 U.S. Environmental Protection Agency.
4 Not analyzed.
5 AA result.
6 Duplicate analyses.
7 No value available.

## TABLE 4. RESULTS FOR SULPHUR BLOCK DRAINAGE POND SLUDGE.

| | | NWL Data | | | QCL Data | | |
|---|---|---|---|---|---|---|---|
| Parameter | Units | NWL's Digest$^2$ | QCL's Digest$^1$ | Previous Result$^3$ | NWL's Digest$^1$ | QCL Digest$^4$ | Previous Result$^3$ |
| Loss on drying | % | 36.3 | (5) | 44.8 | 34.8 | (5) | 38.2 |
| Ammonia-N | ug/g | 56 | (5) | 30 | (5) | 138 | 58 |
| Cyanide | ug/g | 48 | (5) | 17 | (5) | 2.3 | 2.8 |
| Phenols | ug/g | 0.1 | (5) | LT0.2 | (5) | 0.3 | 3.2 |
| Mercury | ug/g | 0.07±0.01$^6$ | (5) | 0.081 | (5) | 0.029$^6$ | 0.005 |
| Cadmium | ug/g | 0.8±0.7 | 0.7±0.4 | 0.33 | LT0.25 | LT0.25 | LT0.5 |
| Chromium | ug/g | 130$^6$ | 64 | 64 | 59±20 | 42 | 44 |
| Lead | ug/g | 17±11 | 13 | 14 | LT2.5 | 4±1 | 8.6 |
| Nickel | ug/g | 9.0 | 8.8 | 8.3 | 11 | 11 | 8.6 |
| Zinc | ug/g | 58 | 45 | 47 | 51 | 46 | 38 |
| Copper | ug/g | 22 | 21 | 19 | 20 | 19 | 18 |
| Arsenic | ug/g | 6.0$^6$ | (5) | 4.6$^6$ | 5.8$^6$ | 5.3$^6$ | 3.6 |
| Selenium | ug/g | 0.025$^6$ | (5) | LT0.03 | (5) | LT0.1$^6$ | 0.65 |
| Aluminum | % | 2.2±1.2 | 1.6 | 1.7 | 4.0 | 2.2 | 1.7 |
| Barium | ug/g | 160 | 220 | 160 | 54±23 | 150 | 240 |
| Boron | ug/g | 0.3±0.2 | 55 | 10 | 3.5 | 14 | 11 |
| Cobalt | ug/g | 4±2 | (5) | 2.3 | 7.3 | 5.0 | 4.0 |
| Iron | % | 0.5±0.3 | 0.81 | 0.66 | 0.80 | 0.93 | 0.68 |
| Manganese | ug/g | 37±20 | 75 | 47 | 73±9 | 60±40 | 53 |
| Molybdenum | ug/g | 4±3 | LT0.5 | LT2 | 3.0 | 1.8 | 1.6 |
| Vanadium | ug/g | 72 | 61 | 39 | 61 | 53 | 43 |

Notes:

1 Only plasma analysis was done on exchanged digests, except as noted.
2 Means of duplicate analyses. Range given if greater than 10% of mean.
3 From main study.
4 Means of triplicate analyses. Range given if greater than 10% of mean.
5 Not analyzed.
6 AA spectrometer analysis.

**Results of the follow-up analyses.** The discrepancies between results for phenols, mercury and selenium were largely resolved, essentially in favour of the earlier values given by NWL. However, the new estimates of ammonia-N in the sulphur block drainage pond sludge were approximately double the old ones (possibly due to ammonia sorption during storage of this acidic sludge) and the discrepancy of a factor of about 2 remained. These discrepancies in ammonia-nitrogen values were probably due to analysing the steam distillate from a sludge sample at QCL, rather than the KCl extract at NWL. The following set of measurements were done at NWL as part of the follow-up study.

Ammonia-N (ppm)

| | KCl Extraction + Colorimetry | Distillation + Colorimetry | Distillation + Titration |
|---|---|---|---|
| EPA MDS | 1700 | 2100 | 3900 |
| S-block sludge | 56 | 120 | 160 |

Clearly, distillation extracts more ammonia than extraction with KCl does. The result obtained at NWL by distillation and colorimetry agrees quite well with QCL's. Also, steam-volatile alkalis other than ammonia interfere with the estimate of ammonia-N by distillation and titration. It is not known at NWL whether the documented value of 1620 ppm given by the EPA for the MDS is an extraction or a distillation result.

Of more concern is the much higher value found, in the follow-up work by NWL, for cyanide in the sulphur block drainage pond sludge; QCL essentially confirmed their earlier result. Large concentrations of cyanide are unexpected in acidic samples (though some complex metal cyanides are very stable) so NWL's result is suspect. Both labs used the acid distillation method of Knechtel and Conn(1979) but NWL used a colorimetric finish whereas QCL used a cyanide-specific electrode to analyze the distillate. Unfortunately, no reference material of known cyanide content was available. The discrepancy remains unresolved.

## METALS ANALYSIS

The labs had been asked by Monenco Consultants to prepare nitric/perchloric acid digests of the sludges and to analyze these digests, wherever possible, for metals by plasma analyzer. Atomic absorption analysis would be used as a back-up procedure (except of course for those metals requiring it in the first instance). This approach had the assent of the labs involved and was considered convenient and economical.

Judging from the results of the follow-up study, analyses for lead and barium were subject to either variable recoveries in the digestion process or interference effects on measurement by plasma analyzer. (Sludges generally contain significant amounts of clay, and therefore of acid extractable Al, but this fact is not regarded as being of environmental significance, so the variability also seen in results of Al analysis is considered only a nuisance.)

Boron analysis seemed to involve similar but even more serious difficulties; boron was either being lost on digestion (Wikner, 1986) or was subject to interference in measurement by plasma analyzer.

## Metals analysis for Canmet standard soils

The results of the separate QC exercise referred to above, in which both labs were asked (blind) to analyze Canmet soils (a typical set of results is shown in Table 5) also indicated that, despite good within-lab replication, the two labs were having difficulties reaching close agreement on concentrations of metals, even when the materials involved were well homogenized and uncontaminated with oil. The impression was forming that inter-lab differences in preparing and analyzing nitric/perchloric acid digests of the materials must have contributed to observed discrepancies. For example, NWL but not QCL prepared a separate digest for chromium analysis, at a lower than usual temperature, to avoid loss due to volatilization (McKeague, 1978). Wide discrepancies in chromium analysis were observed between the two labs (see Table 2).

## Conclusions from the main study

The CPA's steering committee over-seeing the project had expected much closer agreement betweeen results from different laboratories; they were not very receptive to the author's personal view that, for practical purposes, analytical values agreeing within a factor of 2 are generally adequate for forensic or "characterization" purposes.

Dissatisfaction at the outcome of the project was also felt by staff at the labs involved; after the follow-up study, further additional work was undertaken at NWL to investigate methods of analysis for metals in sludges. In this later work, the intention was to find a method of sample digestion that (1) was less technician-dependent and less subject to losses than open-beaker, multi-acid methods and (2) gave a digest amenable to reliable measurement of metals by plasma analyzer.

## TABLE 5. RESULTS OF ANALYSIS OF CANMET STANDARD SO-4

| Element | QCL value | NWL value | Recommended value |
|---|---|---|---|
| B | 17 | 18 | - |
| Cd | < 0.25 | 0.5 | - |
| Cr | 38 | 46 | 61 |
| Cu | 22 | 21 | 22 |
| Ni | 30 | 20 | 26 |
| Pb | 15 | 12 | 16 |
| Zn | 105 | 89 | 94 |
| V | 89 | 61 | 90 |
| Co | 14 | 8.3 | 11 |
| Mo | < 0.5 | < 1 | - |
| Mn | 750 | 580 | 600 |
| Hg * | 0.023 | 0.03 | 0.030 |

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* Mercury by atomic absorption, other metals by plasma instrument after nitric/perchloric acid digestion. Results in ug/g of dry material.

## NITRIC ACID DIGESTION IN SEALED CONTAINERS

Previous work (De Walle et al.,1980; Miller et al., 1981) has shown that good recoveries of total metal contents of contaminated materials can be achieved by nitric acid digestion in sealed containers. Any "mild" digestion method (one which does not recover the entire analytical content of each element in a material) is unsatisfactory in the sense that it cannot be fully verified using standard materials of known total composition. This criticism can of course be levelled against nitric/perchloric acid digestion and possibly contributed to the discrepancies seen in the main study. However, an advantage of mild methods of digestion is that they recover the labile component of the element of interest but not the component that is part of the matrix of the material, which from the environmental standpoint is an irrelevant constituent. An advantage of sealed containers is that loss due to volatilization is prevented; also, digestion in stages (with partial evaporation before adding another acid) is eliminated, thus avoiding an operation which, with multi-acid methods, depends very much on the routine of the individual technician.

### Digestion in Teflon bombs using a pressure cooker

Further follow-up work was done at NWL to investigate the reliability of nitric acid digestion. DeMenna and Edison (1985) have described digestion in Teflon bottles, heated in a pressure-cooker (partly for reasons of safety). Teflon bottles available to NWL were expensive and not robust enough to withstand more than one digestion. However, Teflon bombs (Lorran vessels) available from Seigniory Chemical Products Ltd., Montreal can be used repeatedly which offsets the initial outlay (approximately $200 Canadian each, currently). The chamber and screw-on lid of the bombs are thick-walled and unlikely to rupture on a hot-plate at a low setting but, again for reasons of safety and also for greater consistency from run to run, digestion was done inside a pressure-cooker.

The method was first subjected to a ruggedness test (Youden and Steiner, 1975) in which the parameters varied were mass of dried sample (0.18/0.22 g), volume of nitric acid (2.8/3.2 mL), concentration of acid (63/70%), time elapsed after adding acid before sealing bomb (0/0.5 h), digest time (1.5/2.5 h), time elapsed after making up to 25 mL before filtering under suction through 0.45 micron disc (0/18 h), type of material (Canmet soil SO-1/EPA Municipal Digested Sludge) and type of domestic pressure-cooker (Tefal, 6L/Presto, 6L).

Digests were analyzed by atomic absorption analyzer for chromium, cobalt, copper, lead, manganese, nickel and zinc. The results obtained were converted to parts per million of dried material and compared (Table 6) with the certified values available for the materials.

**Table 6.**
**Ruggedness test of nitric acid digestion in Teflon bombs**

| Metal | Material | Range of metal concentration found (ug/g) | Coefficient of variation (%) | Certified value (ug/g) | Mean recovery (%) |
|---|---|---|---|---|---|
| Cr | EPA MDS | 190-210 | 3.6 | 193 | 104 |
|  | SO-1 | 150-160 | 2.3 | 160 | 97 |
| Co | EPA MDS | 12-15 | 8.0 | NA | - |
|  | SO-1 | 35-37 | 2.0 | 33 | 109 |
| Cu | EPA MDS | 57-65 | 4.8 | 61 | 98 |
|  | SO-1 | 1320-1510 | 4.8 | 1080 | 130 |
| Pb | EPA MDS | 440-540 | 7.3 | 526 | 95 |
|  | SO-1 | < 20 | - | 21 | - |
| Mn | EPA MDS | 190-210 | 3.6 | 202 | 101 |
|  | SO-1 | 670-740 | 3.6 | 890 | 79 |
| Ni | EPA MDS | 170-190 | 4.0 | 194 | 92 |
|  | SO-1 | 77-83 | 2.7 | 94 | 85 |
| Zn | EPA MDS | 1250-1420 | 4.6 | 1320 | 101 |
|  | SO-1 | 128-160 | 7.9 | 146 | 95 |

There was a slight, but not significant inverse dependence in the analytical result on the mass of material used, suggesting that 0.2 g is near the practical maximum allowable for the volume of acid and size of bomb used. With this minor reservation the method is apparently very robust.

## Interlab test of Teflon bomb digestion method

As we have already seen, good within-lab replication of results is no guarantee of between-lab agreement. With this in mind, NWL arranged a small inter-lab study involving the analysis of sludge and sediment materials by the nitric acid/Teflon bomb procedure.

Three materials were employed; NBS River Sediment Standard #1645 (RSS), a gas-plant sludge used at NWL as an in-house standard (IHS) and a remnant of the dried sulphur block drainage pond sludge (SDS) from the main study described above. The IHS and SDS are both oil-contaminated. Several grams of the IHS and SDS materials (already dried and machine ground) were hand-ground in an agate mortar at NWL and 1 gram sub-samples placed in glass vials. Sub-samples of the RSS standard, taken from a batch supplied by NBS, were placed in glass vials without further preparation.

The sub-samples were sent to two other labs (identified below as Lab A and Lab B) with the set of instructions for digestion given in the Appendix. The labs were not asked to provide any QC measures in addition to their normal QC routine. Lab B commented that they further ground their sub-samples of the IHS and SDS materials by hand before analysis, because coarse particles were visible.

**Results of the inter-lab study.** All three labs analyzed replicate digests using an ICP instrument. The suite of elements for which results were reported was not the same for each lab but there was a common core of 13 elements and 8 more were measured by two out of the three labs. NWL also analyzed its digests for some metals by atomic absorption spectrometer and for potassium by flame photometer.

In the results for the RSS material (Table 7) there was good inter-lab agreement and recovery of most of the certified content of each element for calcium, magnesium, chromium, manganese, zinc and lead. Reasonably good agreement and recovery were seen also for copper, cadmium, iron and nickel. Good agreement, but without the reinforcement of a certified value, was also seen for barium, phosphorus and titanium (results not reported by one lab). Recoveries of copper, lead, zinc, phosphorus, iron, manganese and cadmium were generally similar to those obtained for this material by Willett and Zarcinas (1986) using nitric acid digestion in open tubes.

Poor agreement was observed for beryllium, boron, cobalt, vanadium and molybdenum.

Similar results were obtained with the other materials (Tables 8 & 9) although there was a discrepancy between results for lead in the SBS material; for both materials, no certified values were available, only results from previous analyses by NWL in the case of the IHS material and by NWL and QCL in the case of the SBS material.

Table 7. Results of inter-lab analysis of NBS SRM #1645 River Sediment Standard (in ug/g unless stated)

| | NWL results | | | | Cert | Typical |
|---|---|---|---|---|---|---|
| **Element** | **ICP** | **AA** | **Lab A** | **Lab B** | **Value** | **Soil *** |
| Ag | - | - | - | < 1 | - | 0.05 |
| As | - | - | - | 47** | (66) | 5 |
| B | < 5 | - | 340 | < 10 | - | 10 |
| Ba | 51 | - | - | 40 | - | 430 |
| Be | (8) | < 6 | - | 73 | - | 6 |
| Ca | 2.9% | - | 3.1% | 2.5% | 2.9% | 1.4% |
| Cd | (8) | 13 | - | 7 | 10.2 | 0.5 |
| Co | 21 | 10 | 69 | 9 | 10.1 | 8 |
| Cr | - | 2.0% | 2.9% | 2.5% | 2.96% | 100 |
| Cu | 66 | 73 | 100 | 88 | (109) | 30 |
| Fe | 7.2% | - | 8.1% | 6.5% | 11.3% | 3.8% |
| K | (0) | [0.035%] | < 0.003% | < 0.03% | 1.26% | 0.8% |
| Mg | 0.72% | - | 0.76% | 0.60% | 0.74% | 0.5% |
| Mn | 580 | - | 700 | 530 | (785) | 600 |
| Mo | (5) | < 13 | (16) | 27 | - | 2 |
| Na | (0.06%) | 0.17% | 0.09% | 0.09% | 0.54% | 0.6% |
| Ni | 34 | - | - | 34 | 45.8 | 40 |
| P | (440) | - | - | 420 | - | 600 |
| Pb | 710 | - | - | 600 | 714 | 10 |
| Ti | 110 | - | - | 100 | - | 0.4% |
| V | (11) | < 40 | - | 51 | (24) | 100 |
| W | - | - | - | < 5 | - | 2 |
| Zn | - | 0.19% | 0.18% | 0.14% | 0.172% | 50 |

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( ) implies value is near limit of measurement or that replicate results range over more than 10% of the mean.

[ ] flame photometer value ** graphite furnace AA value

* values from "Chemical Equilibria in Soils", Lindsay - except for cadmium and tungsten values, from "Trace Elements in Soils and Plants", Pendias.

Table 8. Results of inter-lab analysis of NWL's In-House Standard Sludge (IHS) (in ug/g unless stated)

| Element | NWL results ICP | NWL results AA | Lab A | Lab B | Previous Value* |
|---|---|---|---|---|---|
| Ag | - | - | - | <1 | - |
| As | - | - | - | 17** | - |
| B | (5) | - | 180 | < 10 | - |
| Ba | (220) | - | - | 330 | 300 |
| Be | (1.5) | < 6 | - | 45 | 1.5 |
| Ca | 1.9% | - | 2.0% | 1.4% | 1.8% |
| Cd | (5) | 3.8 | - | 2.0 | (4) |
| Co | 10 | 11 | 56 | 9.0 | (30) |
| Cr | 310 | 230 | 290 | 210 | 250 |
| Cu | 220 | 220 | 260 | 250 | 250 |
| Fe | 4.6% | - | (4.6%) | 3.9% | 4.0% |
| K | 8 | [780] | (800) | (540) | - |
| Mg | 0.23% | - | 0.17% | 0.13% | 0.20% |
| Mn | 490 | - | (540) | 560 | 400 |
| Mo | (4) | < 13 | (16) | 10 | (4) |
| Na | 1200 | 1800 | 1600 | 1100 | (3000) |
| Ni | 43 | - | - | 32 | 37 |
| P | (860) | - | - | 410 | - |
| Pb | 1400 | - | - | 1100 | 940 |
| Ti | 6 | - | - | 5 | (8) |
| V | (13) | < 40 | - | 24 | 21 |
| W | - | - | - | 8 | - |
| Zn | - | 2400 | (2900) | 2000 | 1700 |

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* NWL value obtained in previous in-house study

[ ] flame photometer value ** graphite furnace AA value

( ) imprecise value (range > 10% of mean)

Table 9. Results of inter-lab analysis of sulphur block drainage pond sludge (SBS) (in ug/g dry material unless stated)

| | NWL results | | | | Previous nitric/ |
|---|---|---|---|---|---|
| Element | ICP | AA | Lab A | Lab B | perchloric value* |
| Ag | - | - | - | < 1 | - |
| As | - | - | - | 8** | - |
| B | (1) | - | (43) | < 10 | - |
| Ba | 200 | - | - | 280 | 280 |
| Be | (0.1) | < 6 | - | 6 | - |
| Ca | 930 | - | (890) | 720 | - |
| Cd | (0.8) | < 1 | - | (1) | 0.5 |
| Co | (4) | (3) | (13) | 3 | 6 |
| Cr | 91 | 84 | 96 | 80 | 150 |
| Cu | 21 | 25 | (42) | 22 | 29 |
| Fe | 0.57% | - | 0.71% | 0.54% | 1.1% |
| K | 6 | [780] | (780) | 800 | - |
| Mg | 0.12% | - | 0.13% | 0.11% | - |
| Mn | 40 | - | (43) | 41 | 90 |
| Mo | 3 | < 13 | (6) | 5 | 3 |
| Na | < 10 | 360 | (260) | 150 | - |
| Ni | (9) | - | - | 11 | 14 |
| P | 450 | - | - | 400 | - |
| Pb | (30) | 24 | - | < 5 | 15 |
| Ti | 8.1 | - | - | 12 | - |
| V | (20) | < 40 | - | 17 | 90 |
| W | - | - | - | < 5 | - |
| Zn | 28 | < 100 | (60) | (41) | 80 |

---

* mean result obtained by NWL and QCL in main study (Table 1, values expressed now on dry weight basis). The SBS remnant used in the inter-lab study may not have been truly representative of the sludge used in the main study

( ) imprecise result (range greater than 10% of mean)

[ ] flame photometer value ** graphite furnace AA value

All three labs reported very low recoveries of the certified total sodium and potassium contents of the RSS material.

**Discussion of results.** It is important to try to ascertain whether discrepancies were due to erratic recoveries on digestion, analytical errors or both. The low recoveries of Na and K in the digest from the RSS material were essentially verified later by atomic absorption and flame photometer analysis of NWL's digests, although all ICP values (especially NWL's) for Na and K look low compared with these later results. The poor recovery of these elements (rather surprising in view of the excellent recoveries of Ca and Mg) must be due to their insolubility in nitric acid. As already pointed out, this implies that the Na and K contents of this material are largely part of its structural matrix and not of environmental significance.

Atomic absorption analysis of the digests of the RSS material prepared at NWL gave generally similar results to those obtained by ICP, except for a lower Co value (now in line with the NBS certified value).

It seems most unlikely that the digestion method would give reproducible recoveries of most elements, but widely variable recoveries for some others. These findings, therefore, suggest that lab A's results for Co and lab B's results for V, Mo and Be are erroneously high. Lab A's results for boron are also very high in comparison with the results from the other two labs.

Where certified values of elemental concentrations are not available, typical concentrations for soil can be used as a guide (Table 7). It can be seen that the elements showing serious inter-lab discrepancies (namely boron, beryllium, cobalt, molybdenum, lead and vanadium) are present (or probably present) at concentrations no higher than about 20 ug/g of dry material.

Using the digestion method employed in the inter-lab study (see the Appendix) this concentration level is equivalent to about 0.2 ppm in the diluted digest used for analysis. Another metal whose concentration would normally fall well below this level, and which might therefore have been expected to be subject to poor inter-lab agreement, is cadmium; the reasonable agreement actually reached may be due to the high sensitivity of ICP instruments towards cadmium.

## CONCLUSIONS FROM THE INTER-LAB STUDY

Digestion in Teflon bombs using concentrated nitric acid holds promise as a method of providing a reproducible digest for characterizing gas-plant and other sludges for their content of extractable metals. However, analyzing the digest by ICP is likely to give reliable results only for those metals that are present in concentrations such that the digest contains no less than about 0.2 ppm. This limit will of course vary from element to element, and is rather high compared with detection limits for most elements (especially Cd) in aqueous solution. However, it would seem to be a pragmatic borderline value for analysis of acid digests, below which AA techniques should prudently be employed, because of the possibility of interferences from the large concentrations of other elements in the digest.

Labs would also be well advised to make standard additions, of metals likely to fall below this rough limit, to the material being analyzed in addition to running the usual duplicates and standards for QC purposes.

Solvent extraction techniques have the potential to improve this limit of measurement considerably, of course, but employing these adds to the expense and complexity of analysis. A viable alternative may be to use larger, custom-built bombs so that the digest need be only slightly diluted in order to provide the volume required for analysis.

It is in the long-term interests of the energy industry and appropriate state agencies to provide funding for further reasearch into analytical methods, in order that inter-lab agreement on analytical results can be improved. Other labs have willingly co-operated with NWL in these studies, but such work tends to be given a low priority unless there is some financial return for the effort involved.

Another area needing research is that of diagnostic criteria for sludges and other wastes. The author's personal impression (which may well be incorrect) is that the main study was undertaken with an eye to the future decommissioning of gas plants and the fate of sludges generated there. Sensible interpretation of analytical results, based on objective criteria, will be required; at present such criteria are largely lacking.

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## APPENDIX

### Method of preparation of nitric acid digest

1. Use thick-walled Teflon bombs, 15 mL approx. capacity (Lorran)

2. Sample must be well homogenized; sample weight must be within 10% of 0.2 gram. Record the exact weight (w) on a 4 decimal balance.

3. Add exactly 3 mL of concentrated (70%) nitric acid by pipet.

4. Close lid as firmly as possible by hand.

5. Place bombs upright in pressure cooker (any domestic make, capacity 5-10L) and add water so that bombs are standing in about 2-3 cm.

6. Seal the pressure cooker and bring to the boil. Lower heat and simmer (steam gently escaping past counterweight) for 2 hours.

7. Remove bombs; open when they are cool enough to be handled without gloves. Pour contents into a 100 mL beaker with spout and from there into a 25 mL volumetric flask. Wash bomb out into beaker and transfer all rinsing water to the flask. Make up to the mark and shake to mix.

8. The flask contents may be filtered at once or allowed to settle overnight. Filter under suction through a 0.45 micron disc and retain the filtrate for analysis.

9. Express the analytical result (p.p.m. in solution) as parts per million of material by multiplying by 25/w.

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# GROUNDWATER AND SURFACE WATER MONITORING AT ALBERTA'S SPECIAL WASTE FACILITY

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## INTRODUCTION

### Background

The Alberta Special Waste Management Corporation, a crown corporation, has been charged with overseeing the development of a system and facilities for handling and disposing of special wastes generated in Alberta. A processing and disposal facility is in the final stages of construction near the Town of Swan Hills about 200 km northwest of Edmonton. Solid and liquid wastes will be accepted and processed at the site through a variety of systems which include incineration, physical chemical treatment, stabilization, secure landfilling and deep well injection of treated residues. The facility will be operated by a private contractor, Chem-Security Ltd., with the Corporation ensuring that the interests of the general public are fulfilled.

Stanley Associates Engineering Ltd., a firm of hydrogeologists, engineers, planners and economists, was selected to design, install and operate a groundwater and surface water monitoring system in the vicinity of the facility. The mandate was to impliment a state-of-the-art system that would provide valid, long-term results. A detailed protocols manual was produced to document equipment, installation procedures and sampling methods. Beak Associates Consulting Ltd. was selected by Stanley to undertake the biophysical monitoring component of the surface water monitoring system.

### Physical Setting

The Facility is located near the crest of the Swan Hills about 200 km northwest of Edmonton. The specific location is on the eastern slopes of the Swan Hills where the land surface drops some 1000 m over a distance of 20 km. The area is forested with poplar and fir, and muskeg is common.

The site is in the headwaters of the Coutts River system. This river drains north to the Lesser Slave River and subsequently to the Athabasca River. The facility site itself drains in all directions to various minor tributaries of the Coutts River. Due to the headwaters setting, all of the streams adjacent to the site are ephemeral in nature. Permanent flow conditions generally do not occur until within 2 km of the site, and even these sites freeze to bottom in winter.

Climatic data have not been recorded until recently at the Town of Swan Hills. As measured at Whitecourt 80 km away, average July temperature is about 15°C while January averages -17°C. Annual precipitation at Whitecourt is approximately 400 mm with over 70% occurring in June, July and August.

## GROUNDWATER MONITORING

### Site Hydrogeology

The site is located in an area where glacial till of 4 to 16 m thickness overlies shales and bentonite sandstones of Cretaceous age. The till is dense and generally unfractured and has hydraulic conductivities in the range of $10^{-6}$ to $10^{-9}$ m/s. The higher conductivities generally occur at shallow (0-5 m) depths and the lower values at greater depths.

Mudstones and poorly consolidated shales underlie the glacial till. A fine-grained sandstone occurs at depths of about 50 to 60 m below the site. This is, in turn, underlain by shale to undetermined depths.

A water table is found within 5 m of land surface. Saturated conditions generally prevail to the base of the till, where unsaturated conditions prevail.

The next saturated zone occurs within the sandstone at about 50 m depth. Water supply for the facility is provided from this zone. It is unknown whether the patterns of alternating saturated/unsaturated conditions continues to greater depths.

Groundwater flow is generally slowly eastward and strongly downward in the till. Flow in the sandstone appears to be eastward to springs located on the steep slopes found there.

## Monitoring System

The philosophy of the groundwater monitoring program centers about the establishment of "background" and "facility" sites. Background monitoring sites determine the general groundwater conditions in the area before waste is delivered. Facility monitors would be installed if required by regulating agencies and would be located close to such features as landfills, lagoons or incinerators.

The groundwater monitoring system consists of ten piezometer "nests" surrounding and within 5 km of the perimeter of the facility. Each of these nests consists of two piezometers completed at depths of approximately 5 and 15 m. At four sites, located at the corners of the facility, additional piezometers about 60 m deep have also been installed.

Two sets of piezometers were installed at each site at similar depths. Piezometers constructed of PVC are utilized for water level measurements while others constructed of 51 mm O.D. stainless steel are used solely for sampling. Stainless steel was selected for monitoring piezometer construction because it is relatively inert, will not interfer with organic analysis and was acceptably priced. PVC, PTFE, polyethelene and fibreglass materials were rejected.

Construction, except for the four deep piezometers, was accomplished with hollow-stem augers. This allowed for detailed placement of sand packs and peltonite seals. The deep piezometers were installed using an air-rotary drilling rig.

High standards of cleanliness were undertaken. All piezometer materials were specified factory cleaned and were further rinsed with acetone and steam cleaned on site prior to installation. The drilling rigs were steam cleaned on site and PTFE-based pipe compound utilized throughout the program.

Sampling is accomplished by a dedicated system consisting of one of two types of apparatus. Where the piezometer terminates less than 6 m below surface a dedicated teflon-tube is used with a peristaltic pump to obtain samples by suction lift. At greater depths dedicated bladder pumps, constructed of stainless steel and PTFE, are utilized.

Sampling takes place quarterly. Some shallow piezometers freeze; therefore the number of samples per year in each piezometer may actually be three rather than four. Table 1 gives the chemical parameters be analyzed.

Sampling began in the spring of 1985; therefore two complete years of data have been collected prior to the testing of the incinerator this year. This testing will be defined as the termination of background monitoring at the facility.

### Analytical Program

Analysis of water samples is for the parameters listed on Table 1. An allowance is made for 10 to 15% duplicates and blanks for quality control. An objective of the monitoring program is to rationally reduce the number of samples and frequency of sampling. Statistical analysis is being conducted to achieve this goal.

## SURFACE WATER MONITORING

### Monitoring System

The surface water monitoring network was designed to measure stream flow, water quality, sediment chemistry and benthic invertebrate community structure (i.e. biomonitoring) in the various surface streams draining the area surrounding the facility site. In addition, fish in Windy Lake, *** km to the northeast of the facility, were sampled for heavy metals and trace organics.

Five sites were originally selected for the network in 1985-86. A sixth site was added in 1986 to better monitor conditions upstream of the facility. Water quality and stream flow are measured three times each year (spring, summer, fall) at all sites. Winter water quality is measured at the single site (S1 - outlet of Windy Lake), the only site where year-round flow occurs. Continuous water level recorders were established during each summer in order to establish stage-rainfall event relationships.

Benthic invertebrate communities were sampled in the fall of 1985, and the spring and fall of 1986. Sediment samples were collected in the fall of 1985. Fish tissue was collected in the fall of 1985 and 1986 and in the spring of 1987.

Surface water quality and sediment sampling procedures were routine, with samples preserved in the field following Standard Methods. Five replicate benthic invertebrate samples were collected at each site along with data on physical habitat (water depth, water velocity, substrate types). Fish sampled for tissue analysis were categorized by age, and a composite tissue sample prepared for each age class.

### Analytical Program

The surface water quality parameters analyzed are also shown in Table 1. A full suite of metals/major ions analysis using ICP, and analysis for EPA Priority Pollutants was carried out for the sediment samples. Benthic invertebrates were identified to the lowest practical taxonomic unit (generally species) and their community structure assessed using a variety of statistical techniques. Only benthic data collected in the fall of 1985 and 1986 have been analyzed to date. Fish tissue samples were analyzed for metals (AA) and for priority pollutants (GC/MS).

## RESULTS

### Groundwater

Table 2 presents the results of 1985 and 1986 groundwater analyses at Site 1 for the shallow, intermediate and sandstone piezometers. Five separate analysis are included in the mean and standard deviations shown on this table.

The chemistry of groundwater at the shallowest water table at site 1 (shallow piezometer) at a depth of 4 m is classified as calcium/magnesium - bicarbonate. Total dissolved solids has a mean value of 305 mg/L. Variations in time, as measured by standard deviation, do occur but are reasonably small. Metals concentrations are relatively low.

## TABLE 1
## GENERAL SUITE CHEMICAL ANALYSES

### Routine Potability

Calcium
Magnesium
Sodium
Potassium
Chloride
Sulphate
pH
Carbonate
Bicarbonate
Dissolved Oxygen *
Turbidity *
BOD *
Phenolphthalein Alkalinity
Total Alkalinity
Total Hardness
Hydroxide
Fluoride
Conductance
Sulphide
Nitrite Nitrogen
Nitrate Nitrogen
Total Filterable Residue
Cyanide
Apparent Colour *

### Organics

Tannin and Lignin
Chemical Oxygen Demand
U.S.E.P.A. Priority Pollutants
Phenols
Total Organic Carbon

### Metals and Non-Metals

Aluminum
Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Chromium
Copper
Iron
Lead
Manganese
Mercury
Nickel
Selenium
Silver
Thallium
Zinc

* Surface Water Samples Only

The mean values observed for the shallow piezometer at Site 1 are not significantly different than the mean values for all shallow piezometers. This likely indicates a relatively small time-and-space variation in chemistry at the facility.

The intermediate piezometers, completed near the base of the uppermost watertable at a depth of 9 m, contain water that may still be classified as calcium/magnesium -bicarbonate. At this depth, however, the relative amounts of sodium and sulfate have increased substantially. Total dissolved solids have more than doubled over the 5 m depth difference to 641 mg/L. Iron concentrations are quite high; however other metals are not particularly elevated.

The sandstone piezometer, completed at a depth of 65 m at Site 1, yields water which can be classified as sodium-bicarbonate with significant calcium also present. Total dissolved solids average 324 mg/L. Average arsenic levels are very high, however other metals concentrations appear similar to shallower zones.

Analysis for organic parameters by GC/MS techniques has revealed very few compounds - as would be expected in this setting. Of the priority pollutants, only one has been identified - dibutyl phtalate at concentrations of approximately 0.4 micrograms/L. This compound is a plasticizer and is felt to be present due to some impurity in the pumps or flow lines. Other, non-target organic compounds identified include phtalate isomers, long-chain alcohols and some alkane compounds. All of these compounds appear in water samples from two wells which lends credence to the belief that they are due to the pumping equipment.

### Surface Water

The area surface streams are small and respond rapidly to the heavy summer storm events which are common in the area. Spring flows generally range from 0.2 to 0.5 $m^3/s$, declining steadily over the summer to 0.03 to 0.08 $m^3/s$ in the fall. Storm events, which are very short lived, have not yet been adequately monitored, and so the present stage/rainfall event relationship is considered unreliable.

Table 3 summarizes surface water quality data for 1985-86. Major ions at all sites were calcium and bicarbonate. Seasonal trends, if any, were masked by effects of flow conditions on the dates sampled. A general increase in most parameters was noted in a downstream direction. All parameters were felt representative of natural, undisturbed conditions.

Two distinct stream reaches, based on physical habitat measurements made during the benthic invertebrate monitoring program, were defined, with greater depths, lower stream velocities and finer substrates in the lower reach. Taxa at all sites were typical of Alberta foothills streams and dominated by chironomids (midges) and other dipteran larvae in the upstream reach, and by worms in the downstream reach. Statistical analysis (ordination and clustering) confirmed the presence of two distinct benthic communities.

Results of sediment analysis found non-detectable levels of acid compounds, and low levels of base neutral organics. Little confidence was placed in the identification of specific compounds. Fish tissue analysis for metals was extremely variable between years (1985-86) with no discernible trends. Data from 1987, which are not yet available, will be required to draw any conclusions. Two priority organic pollutants (4-nitrophenol and pentachlorophenol) were identified at near detection limits in fish tissue in 1985, but were not observed in 1986 samples.

## CONCLUSIONS

The Alberta Special Waste Management Facility at Swan Hills is being rigorously monitored with respect to surface water and groundwater. Background conditions were well established prior to the first test burn of the incinerator in June, 1987.

## TABLE 2
## SITE 1 - INTERMEDIATE PIEZOMETER

| Parameter | Mean (mg/L) | Standard Deviation (mg/L) |
|---|---|---|
| Cu | 135 | 17 |
| Mg | 32 | 2.4 |
| Na | 48 | 4.8 |
| K | 5.4 | 0.2 |
| Cl | 3.1 | 1.2 |
| $SO_4$ | 165 | 15 |
| pH | 7.8 | 0.2 |
| $HCO_3$ | 492 | 43 |
| Tanin & Lynin | 0.5 | 0.3 |
| COD | 14 | 6.7 |
| Phenol | ND | --- |
| TOC | 4.7 | 1.4 |
| TDS | 641 | 33 |
| As | 0.5 | 0.08 |
| Cd | ND | --- |
| Cr | 1.6 | 1 |
| Cu | 8 | 6 |
| Fe | 56 | 97 |
| Pb | 2.8 | 0.8 |
| Hg | ND | --- |
| Ni | 49 | 48 |

ND - Not Detected

## TABLE 2 - GROUNDWATER CHEMISTRY
## SITE 1 - SHALLOW PIEZOMETER

| Parameter | Mean (mg/L) | Standard Deviation (mg/L) |
|---|---|---|
| Ca | 8 | 7 |
| Mg | 21 | 3 |
| Na | 8.6 | 1 |
| K | 2.0 | 0.2 |
| Cl | 1.3 | 0.3 |
| $SO_4$ | 5.5 | 2.5 |
| pH | 7.5 | 0.3 |
| $HCO_3$ | 365 | 33 |
| Tanin & Lynin | 0.7 | 0.2 |
| COD | 15 | 14 |
| Phenol | 0.003 | 0.001 |
| TOC | 3.6 | 1.0 |
| TDS | 305 | 29 |
| As | 1.6 | 0.9 |
| Cd | ND | --- |
| Cr | 1.8 | 1.8 |
| Cu | 3.0 | 3.0 |
| Fe | 0.7 | 1.1 |
| Pb | 2.0 | 0.4 |
| Hg | ND | --- |
| Ni | 32 | 19 |

ND - Not Detected

## TABLE 2 - GROUNDWATER CHEMISTRY
## SITE 1 - SANDSTONE PIEZOMETER

| Parameter | Mean (mg/L) | Standard Deviation (mg/L) |
|---|---|---|
| Cu | 40 | 5.9 |
| Mg | 6 | 1.1 |
| Na | 72 | 4.7 |
| K | 7.2 | 0.3 |
| Cl | 1.1 | 0.3 |
| $SO_4$ | 36 | 4.4 |
| pH | 7.7 | 0.2 |
| $HCO_3$ | 309 | 31 |
| Tanin & Lynin | 0.4 | 0.2 |
| COD | 19 | 12 |
| Phenol | ND | --- |
| TOC | 2.7 | 2.1 |
| TDS | 324 | 23 |
| As | 58 | 23 |
| Cd | ND | --- |
| Cr | 1.4 | 0.9 |
| Cu | 5.4 | 7.6 |
| Fe | 0.05 | 0.06 |
| Pb | 2.2 | 0.4 |
| Hg | ND | --- |
| Ni | 31 | 8.9 |

ND - Not Detected

## TABLE 3
## AVERAGE WATER QUALITY, 1985-86 - AT ALL SITES SAMPLED.

| | | Means | | | | Ranges | | |
|---|---|---|---|---|---|---|---|---|
| Parameter | Units | May | Sept. | Oct. | Yearly# | Max.# | Min.# | Std.Dev.# |
| Calcium | mg/L | 5.48 | 8.62 | 6.43 | 7.06 | 12.30 | 3.70 | 2.56 |
| Magnesium | mg/L | 1.33 | 2.43 | 1.45 | 1.87 | 3.80 | 0.90 | 0.92 |
| Sodium | mg/L | 1.03 | 1.40 | 1.65 | 1.38 | 3.00 | 0.80 | 0.56 |
| Potassium | mg/L | 0.37 | 0.44 | 0.35 | 0.38 | 0.70 | 0.15 | 0.18 |
| Chloride | mg/L | 0.50 | 0.45 | 1.20 | 0.68 | 2.80 | 0.30 | 0.66 |
| Sulphate | mg/L | 4.60 | 4.97 | 3.90 | 4.53 | 5.30 | 2.20 | 0.81 |
| Phenolphthalein Alkalinity | mg/L CaCO$_3$ | *0.10 | *0.10 | *0.10 | *0.10 | *0.10 | *0.10 | |
| Total Alkalinity | mg/L CaCO$_3$ | 16.95 | 28.75 | 20.08 | 22.88 | 42.30 | 9.40 | 9.40 |
| pH | Units | 6.77 | 6.88 | 6.63 | 6.77 | 7.18 | 6.40 | 0.20 |
| Carbonate | mg/L | *0.50 | *0.50 | *0.50 | *0.50 | *0.50 | *0.50 | |
| Bicarbonate | mg/L | 20.68 | 35.07 | 24.48 | 27.90 | 51.60 | 11.50 | 11.50 |
| Total Hardness | mg/L CaCO$_3$ | 19.15 | 31.57 | 22.03 | 25.33 | 46.40 | 13.00 | 10.07 |
| Hydroxide | mg/L | *0.5 | *0.5 | *0.5 | *0.50 | *0.5 | *0.5 | |
| Fluoride | mg/L | *0.05 | 0.10 | 0.32 | 0.14 | 0.35 | *0.05 | 0.129 |
| Conductance | umhos/cm | 38.10 | 57.30 | 44.50 | 48.12 | 75.00 | 26.80 | 14.79 |
| Tannin & Lignin | mg/L | 4.05 | 2.25 | 1.88 | 2.58 | 4.40 | 1.80 | 1.06 |
| Chemical Oxygen Demand | mg/L | 44.00 | 42.33 | 68.75 | 50.50 | 140.00 | 1.00 | 44.17 |
| Cyanide | mg/L | 0.002 | *0.002 | 0.004 | 0.0025 | 0.005 | *0.002 | 0.00096 |
| Dissolved Oxygen | mg/L | | 10.64 | 14.375 | 12.25 | 19.30 | 8.0 | 3.25 |
| Total Organic Carbon | mg/L | 18.50 | 15.50 | 16.78 | 16.45 | 19.80 | 13.50 | 2.08 |
| Nitrite Nitrogen | mg/L | 0.0030 | 0.0040 | 0.0063 | 0.004 | 0.008 | *0.003 | 0.0019 |
| Nitrate Nitrogen | mg/L | 0.0030 | 0.0037 | 0.0078 | 0.005 | 0.011 | *0.003 | 0.0025 |
| Total Filterable Residue | mg/L | 23.75 | 37.17 | 28.50 | 31.00 | 55.00 | 20.00 | 10.75 |
| Aluminum | mg/L | 0.1025 | 0.0850 | 0.1325 | 0.1067 | 0.20 | 0.06 | 0.041 |
| Antimony | mg/L | 0.0015 | *0.0002 | 0.0008 | 0.0008 | 0.0026 | *0.0002 | 0.0085 |
| Arsenic | mg/L | 0.0004 | 0.0007 | 0.0004 | 0.0005 | 0.001 | 0.0002 | 0.0002 |
| Beryllium | mg/L | *0.001 | *0.001 | *0.001 | *0.0010 | *0.001 | *0.001 | |
| Cadmium | mg/L | 0.00125 | *0.001 | *0.001 | 0.0011 | 0.002 | *0.001 | 0.0003 |
| Chromium | mg/L | 0.00225 | 0.00100 | 0.00425 | 0.0025 | 0.007 | *0.001 | 0.0018 |
| Copper | mg/L | 0.002 | 0.001 | 0.0025 | 0.0018 | 0.003 | 0.001 | 0.0007 |
| Iron | mg/L | 0.2625 | 0.6375 | 0.4625 | 0.4542 | 1.46 | 0.19 | 0.32 |
| Lad | mg/L | 0.002 | *0.002 | *0.002 | 0.0020 | 0.002 | *0.002 | |
| Manganese | mg/L | 0.020 | *0.0100 | 0.0425 | 0.0242 | 0.09 | *0.01 | 0.022 |
| Mercury | mg/L | *0.0001 | *0.0001 | *0.0001 | *0.0001 | *0.0001 | *0.0001 | |
| Nickel | mg/L | 0.00375 | 0.00125 | 0.00175 | 0.0023 | 0.004 | *0.001 | 0.0012 |
| Selenium | mg/L | 0.00038 | 0.00038 | 0.00043 | 0.0004 | 0.0008 | 0.0002 | 0.00016 |
| Silver | mg/L | *0.001 | *0.001 | *0.001 | *0.0010 | *0.001 | *0.001 | |
| Thallium | mg/L | *0.0010 | 0.0018 | *0.0010 | 0.0013 | 0.004 | *0.001 | 0.0008 |
| Zinc | mg/L | 0.0250 | 0.0830 | 0.0085 | 0.0388 | 0.22 | 0.006 | 0.0599 |
| Sample Size | | 4 | 4 | 4 | 12 | | | |

# Value from all data collected in 1985-86

* Less than sign

# HOW CLEAN IS CLEAN:
# THE KEY TO REMEDIAL ACTION

by
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## INTRODUCTION

The protection of human health and the environment from the adverse effects of toxic substances is of paramount importance in the decommissioning of industrial sites and the management of hazardous waste sites. Within the past several years a number of jurisdictions in Canada, the United States and Europe have come to realize the potential health and environmental problems associated with contaminants deposited in the soil, and their possible migration into other environmental media (e.g. air, groundwater, surface water). The results of this migration can lead to the exposure of humans and other organisms in the environment to various toxic substances through a variety of migration pathways.

There are numerous industrial installations which become obsolete every year and are shutdown and dismantled. There are also thousands of dumps and waste disposal sites. The common factor for both these situations is that they are potential sources of contaminants, which are a potential threat to human health and the environment.

The first step toward quantifying the potential threat is to identify the toxic substances. This requires site characterization and quantification of contaminants that are present on the site. Procedures for site characterization were detailed in a Guide prepared by Monenco Consultants Limited (1985) for Environment Canada.

The second step involves quantifying the potential threat to human health and the environment. This requires:

- identification of the various pathways by which toxic substances leave the contaminated area (i.e. pathways identification);
- quantification of the amounts of toxic substances in each of these pathways (i.e. pathways quantification);
- determination of the significance of each pathway (i.e. pathway significance); and
- determination of the acceptable levels of toxic substances to which humans and the environment can be exposed (by way of the significant pathways).

The resulting information then becomes the primary basis for the determination of acceptable levels of toxic substances to be left at the decommissioned industrial site or at the waste dump site containing hazardous materials (i.e. the cleanup criteria).

This paper covers the following topics:

- factors to consider in developing cleanup criteria;
- an outline of alternative strategies for setting cleanup criteria;
- a review of existing approaches for setting cleanup criteria;
- a comparison of existing strategies against predetermined factors; and
- a suggested approach to developing cleanup criteria.

## FACTORS TO CONSIDER IN DEVELOPING CLEANUP CRITERIA

Various methods for establishing cleanup criteria have been used by several jurisdictions, usually for specific contaminants or groups of contaminants. Generally, these methods can be divided into two categories as defined by Brown (1986):

- the absolute methods; and
- the relative methods.

The absolute methods for deriving cleanup criteria assume that it is possible to define acceptable concentrations of toxic substances in various environmental media at which adverse effects to humans and the environment would not be expected. Just how "acceptable levels" are defined varies among the methods, but ultimately what is sought is a universally acceptable number (i.e. a standard, guideline or criterion) for a particular toxic substance. To a degree, some of the previously mentioned requirements for quantification of the threat to human health and the environment (i.e. pathways identification; pathway quantification; and pathway significance) are only examined in a cursory manner. The emphasis on the determination of acceptable levels comes not from a detailed review of pathways but rather from:

- previous environmental studies of a particular toxic substance;
- other criteria for toxic substances with similar properties; or
- previous field investigations of toxic substances and exposed populations

The absolute methods have historically been favoured because:

- once a standard is adopted, its application is simple and non-controversial;
- it is easy to justify and defend in court;
- it provides a means of communication between all the technical and nontechnical participants on both sides of the issue;
- it appears to be an objective process grounded in scientific analysis and free of value judgements;
- it relieves policy makers from a cumbersome burden of dealing with uncertainty and from being charged with imposing their own values and beliefs on society;
- it simplifies the problem by automatically determining the goals of toxic substance management activities; and
- it reflects a recurrent hope that we will find a scientific method for objectively resolving the problem of "How clean is clean?".

By contrast, the relative method defines acceptable levels of toxic substances for each particular situation. Much more investigation is made into the previously mentioned requirements for quantification of the potential threat to human health and the environment (i.e. pathways identification, pathways quantification, and pathways significance) prior to determination of acceptable levels for population exposures. Thus, acceptable level is defined for each situation through the risk management process.

Risk management combines risk assessment with the directives of the enabling regulatory legislation, together with socio-economic, technical, political and other considerations, to reach a decision as to whether or how much to control future exposure to the toxic substances. Risk assessment is the procedure used to determine the adverse health and environmental consequences of exposure to toxic substances.

In late 1985 and early 1986 two National Workshops were held in Canada on Industrial Site Decommissioning, Cleanup and Reuse. During these Workshops there was considerable discussion on the topic of "How Clean is Clean?". The Workshop participants indicated that the optimal strategy for cleanup criteria development should be capable of:

- sufficient flexibility so that site specificity can always be maintained despite the wide diversity of sites and situations for which cleanup criteria will be required;
- dealing with all present and future contaminants;
- addressing all environmental media in an integrated, quantitative fashion; and
- examining and incorporating the various levels of risk to human health and the environment associated with the development of cleanup criteria.

## ALTERNATIVE STRATEGIES FOR SETTING CLEANUP CRITERIA

In a publication titled "Superfund Strategy" the Office of Technology Assessment (1985), an independent body reporting directly to the United States Congress, analyzed in detail seven alternative approaches for determining the extent of cleanup required to Superfund sites. The primary focus of four of the approaches is to establish cleanup goals based primarily on current scientific and techncial considerations:

- site-specific risk assessment;
- rational levels (goals) for residual contamination;
- restoration to background or "pristine" levels of chemicals; or
- technology-based standards: best available technology or best engineering judgement.

The fifth approach, the use of cost-benefit analysis, balances the extent of cleanup at each site against cost, with or without a site-specific resource limitation. The sixth approach is a potential-use driven method designed around a classification system based on present and future use of sites. The seventh approach reviewed by OTA is a continuation of the current ad hoc practices.

On the basis of the analysis of the seven alternative strategies, OTA concluded that:

- There is a need to raise the cleanup goals issue to the highest levels of policy making and to have open, public debate on it.
- What is ultimately important and realistically achievable is consistency in the process of determining what the cleanup of sites should be, rather than necessarily making all cleanups the same.
- In setting cleanup levels, it is necessary to examine whether the remedial technologies under consideraton can lead to unintended consequences, including transfer of toxicants among media, transfer of risks among populations, and residual pollution.
- It is no longer acceptable to continue cleanup under the current ad hoc approach.
- Pursuing a strategy of establishing cleanup levels on the basis of background or pristine chemical levels does not make environmental, technical, or economic sense. This approach does not assure protection of health and the environment, in many cases is not possible to achieve, and it would be excessively expensive.
- Although seemingly attractive and extensively used, best available technology or best engineering judgment does not offer environmental protection comparable to the likely high costs of implementation. This approach does not directly address actual or potential exposures threatening health and the environment.
- Although the use of existing standards, risk assessment, and cost-benefit analysis approaches pose considerable problems and have substantial,

## TABLE 1

## COMPARISON OF THE VARIOUS CAPABILITIES OF EXISITNG CLEANUP CRITERIA DEVELOPMENT STRATEGIES

| Jurisdiction | Capabilities | | | |
|---|---|---|---|---|
| | Maintenance of Site Specificity | All Present & Future Contaminants | Address Contaminant Levels in all Media | Incorporate Human & Environmental Health (Risk) |
| Alberta | X | | | |
| Ontario | X | | | X |
| Quebec | | | | |
| California | X | X | X | X |
| New Jersey | X | | | |
| Washington | | X | X | X |
| U.S. Army | X | X | X | X |
| EPA | X | X | X | X |
| Netherlands | | | | |
| United Kingdom | | | | |

X = Strategy used by jurisdiction contains the potential to contain the identified capability.

limitations, they could be used.

The most important conclusion was that a cleanup strategy based on site classification could be the most beneficial approach to pursue.

## EXISTING STRATEGIES FOR SETTING CLEANUP CRITERIA

Existing strategies for establishing cleanup criteria utilized by the following jurisdictions are outlined below:

Canada: Alberta, Ontario and Quebec.
United States: New Jersey, Washington, California, U.S. Army, EPA.
Netherlands and the United Kingdom.

### Alberta

The Province of Alberta has no systematic approach to cleanup criteria selection. Instead, the province requires the responsible company to specify which contaminants exist on site, which contaminants are of concern and the concentrations to which these contaminants must be reduced to protect human health and the environment. The specific criteria developed by this relative method must be supported by appropriate, scientifically defensible data.

### Ontario

The Province of Ontario is currently revising its guide for the restoration and rehabilitation of contaminated industrial sites. This document provides details of the data and information required by the Ontario Ministry of the Environment for the approval of any cleanup plan. In addition, the revised guide will list permissible limits for 13 elements, oil and grease, pH, EC and SAR in soils. These criteria are based on phytotoxicity and the future land use of the site. For contaminants not addressed in the guide, criteria must be developed on a site-specific basis. Risk assessment techniques can be used to develop such site-specific criteria, but the overall approach is similar to an absolute method for cleanup criteria development.

### Quebec

The Province of Quebec has adopted and modified an absolute strategy from the Netherlands for the cleanup of contaminated soil and groundwater. This system provides absolute numbers for concentrations of a wide variety of inorganic and organic contaminants. Three types of values are provided in this so-called "ABC" system:

- Type 'A' values are background or detection limit values;
- Type 'B' values signify moderate contamination; and
- Type 'C' values signify severe contamination.

The various categories of values are meant to provide a guide to the management of contaminated material. Actual management procedures employed may also require the use of risk analysis and assessment.

### New Jersey

The relative method developed by the State of New Jersey is a site-specific strategy for the derivation of an acceptable soil contaminants level (ASCL). This value is the end product of independent calculations describing the:

- human exposure to contaminated soil:
- transfer of contaminants to surface and groundwater;

- human exposure to contaminated surface and groundwater; and
- aquatic biota exposure to contaminated surface water.

If the company responsible for the cleanup desires to conduct a risk assessment in place of ASCL calculations, the state will permit this substitution.

## Washington

The State of Washington has adopted an absolute approach for cleanup of contaminated sites which consists of three priority levels: 1) initial, 2) standard and 3) protection cleanups. The initial cleanup is designed for the immediate removal of material which poses an imminent hazard to human or environmental health. The consequences of delays in cleanup are also inputs into the overall strategy and may become a prominent factor in the initiation of this cleanup level.

If an initial cleanup is not required, the framework directs the user to the standard cleanup level. This level of cleanup is based on the total long-term threat to human and environmental health. If standard level cleanups are not considered necessary, a protection level cleanup based on media-specific existing environmental standards is implemented.

## California

A standardized strategy for the derivation of site-specific cleanup criteria is used by the State of California. termed the "Site Mitigation Decision Tree (SMDT) Process", this relative strategy evaluates both the concentration and movement of individual contaminants through the various environmental media. Based on the long-term toxicity of the contaminant, maximum exposure levels (MELs) and applied action levels (AALs) of specific contaminants in specific media are determined. The contaminant concentrations related to the MELs and AALs are those below which long-term daily exposure is not expected to produce adverse human health effects (MELs) or adverse effects to any biological receptor (i.e. terrestrial or aquatic, fauna or flora) (AALs). Specific contaminant cleanup criteria are determined by "back-calculation" from the human or other biological receptor values for total contaminant exposure (from all environmental media) through the various contaminant transport pathways to the contaminated site.

## U.S. Army

The basis for the U.S. Army's Preliminary Pollutant Limit Value (PPLV) approach is the migration of contaminants from soil via all environmental media and contaminated food to humans. Total human exposure is comprised of inhalation, ingestion and dermal exposure. Each individual pathway by which a contaminant is transported from a site to a human receptor can be mathematically modelled. A critical feature of this relative approach is the determination of the acceptable daily dose of a contaminant by a human receptor. Once this is established, the contribution of each contaminant by each individual pathway is examined and reduced so that the total of all pathways does not exceed the acceptable daily dose. The final step in this process requires a "back-calculation" from the contaminant in each pathway to the appropriate concentration in the contaminated soil.

## U.S. Environmental Protection Agency (USEPA)

The derivation of cleanup criteria by the USEPA is based on the risk assessment process. Site assessment and the determination of contaminant levels in each medium is a critical first step in this relative method. Indicator compounds may be used as surrogates for large numbers of specific contaminants. If existing standards or guidelines are not available for the contaminants or indicator compounds, a comprehensive risk and health assessment is required. This requires extensive use of toxicology and epidemiology data in conjunction with the analysis of the specific pathways by which contaminants leave the site. The determination of a daily contaminant intake is systematically evaluated relative to the number of contaminants in each specific medium and the number of media in contact with the human or other biological receptor. Thus, cleanup criteria are determined so that human exposure to multiple contaminants in multiple media is maintained below the acceptable contaminant intake. For carcinogens (where the preferred total intake is zero) cleanup criteria are derived which limit exposure to the contaminant necessary to maintain a total cancer risk in the range $10^{-6}$ to $10^{-7}$ for a lifetime exposure.

### The Netherlands

The absolute approach taken by the Netherlands consists of predetermined values for the delineation of normal, moderate and severe degrees of soil and groundwater contamination. These three levels are termed 'A' for contaminant values at background levels; 'B' for contaminant levels which require further investigation before a decision can be made regarding cleanup; and 'C' which automatically requires cleanup. Contaminants at level B concentration must be investigated relative to their mobility, potential for adversely affecting public health and the future land use of the contaminated site. The time frame for cleanup is also dictated by this strategy. Contaminants above level "C" concentrations requires immediate action, whereas contaminant concentrations between level "C" and level "B" can be cleaned up over a longer period of time.

### United Kingdom

The absolute approach to the derivation of cleanup criteria is also taken by the United Kingdom and is specifically orientated toward the redevelopment of former industrial sites which are contaminated with elements considered potentially hazardous to human health and plant life. Coal carbonization sites are specifically addressed relative to four types of contaminants associated with this process.

For each of the specified elements or organic mixtures, so called "trigger" concentrations have been produced above which the industrial site is considered to be contaminated. The required cleanup levels are directly related to the future intended land use of the site, with specific upper limits for each contaminant associated with a specific future use.

## COMPARISON OF THE EXISTING STRATEGIES WITH THE OPTIMAL APPROACH

The previous discussion demonstrated the wide variety of approaches developed by various jurisdictions toward the determination of "How Clean is Clean?". How do these approaches compare with the optimal strategy which resulted from discussions at the National Workshops on Decommissioning? As discussed earlier, the optimal strategy should have four basic capabilities:

- the capability to maintain site-specificity;
- the capability to use all present and future contaminants;
- the capability to address all contaminants in all media; and

- the capability to incorporate human and environmental health effects.

Table 1 compares the capabilities of the existing jurisdictional strategies with the four basic capabilities of the optimal strategy. Only the strategies developed by the USEPA, the U.S. Army and California have the capabilities of the optimal strategy. Although the USEPA strategy specifically calls for the selection of indicator compounds at contaminated sites containing a large number of contaminants, the same processes involved in this strategy appears capable of addressing sites with a small number of contaminants without having to resort to the use of indicator contaminants.

All of the strategies having the four basic capabilities of the optimal strategy embody the concept of "back-calculation" from the biological receptor (i.e. human, fish, cow, plant, etc.) to the source of contamination which must be cleaned up (i.e. usually contaminated soil).

While this concept may be time consuming and difficult to fulfill, it does permit the utilization of all available data concerning:

- effects of the contaminant on biological organisms;
- the efficiency of contaminants transport and transformation along various pathways; and
- the efficiency with which the contaminant leaves the original medium of contamination (e.g. soil) and enters a transport pathway.

This is extremely important in the public perception of cleanup criteria development. In essence, the public expects that "all that can be done, will be done" to protect both human and environmental health. Use of the concept of "back-calculation" and the mechanistic details of risk assessment permit the development of a specific numerical value which is scientifically defensible from all points of view.

## RISK ASSESSMENT APPROACH

Although a detailed discussion of risk assessment is outside the scope of this presentation, it is appropriate to define "risk assessment" as the evaluation of specific adverse health consequences of exposure to specific toxic agents. While "the adverse health consequences" usually refer to human health, the phrase may also be used to address environmental health as well. As applied to the development of cleanup criteria, risk assessment is composed of:

- Toxicity Assessment; and
- Exposure Assessment.

Toxicity assessment involves the delineation of the toxic nature of the contaminant or contaminants in question usually by specific routes of exposure (i.e. ingestion, dermal absorption, inhalation). Generally, only laboratory animal (usually rodent) data are available to derive $LD_{50}$s, no-observed effect levels, lowest-observed effect levels, for acute and chronic exposures. Extrapolations of these data from laboratory animals to humans potentially exposed to the contaminant requires the use of uncertainty or safety factors to allow for:

- variability in response to acute and chronic exposure;
- interspecies variability in response to chronic exposure;
- interindividual variability in response to chronic exposure; and if necessary
- variability in response according to the pathway of exposure.

Exposure assessment initially involves all those site characteristics which either promote or hinder movement of the contaminant from the site by a transport pathway. The various pathways by which contaminants leave the site must be analyzed in terms of the contaminants present, the concentrations of contaminants and the dispersive capability of the pathway. The potentially effected populations (e.g. humans, plants, animals) must be identified along with the interactions of the pathways with the potentially effected populations. Certain assumptions must usually be made and safety or uncertainty factors applied to arrive at a specific level of receptor exposure.

Once a specific level of contaminant exposure and the toxic properties of the contaminant are identified a true representation of the adverse health consequences can be determined. The concept of "back-calculation" from the biological receptor through the exposure pathways to the source can then form the basis for the level of contaminant permitted to remain on site (i.e. the cleanup criterion).

A key part of the risk assessment process is consideration of the pathways and transport mechanism by which contaminants can move from the site to the receptor of concern. Monenco, assisted by Senes Consultants Limited and CanTox Inc. has recently commenced a project aimed at developing a decision framework based on modelling the transport and transformation of a contaminant in the environment, from the source of contamination to the receptor of concern. The media to be addressed will include air, soil and groundwater. Funding for this project is being provided by Environment Canada, U.S. EPA, the Provinces of Alberta, Ontario and Quebec, the Canadian Petroluem Association, the Canadian Chemical Producers Association and the Petroleum Association for Conservation of the Canadian Environment. Significant additional funds are also being supplied by the Unsolicited Proposals Program (UPP) of Supply and Services Canada.

Existing pathway-specific models will be selected, based on a set of pre-determined selection criteria. The models will be linked together using computer codes (output from one model will be input to another model). The selected models will be integrated into a computer based expert system, which will assist the users while maintaining the integrity of the overall decision framework. The overall framework will allow the user to develop site-specific cleanup criteria for individual contaminants. This will be based on "back-calculating" from the total human health and environmental risk associated with individual contaminants, through the various transport and transformation pathways to the source of contamination.

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# ENVIRONMENTAL AUDITING

## CANADIAN PRIVATE SECTOR PRACTICES

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## INTRODUCTION

Few issues today hold greater consequence for corporate credibility than those related to the environment. As part of their overall approach to environmental protection, many firms are now applying a management practice known as environmental auditing.

Environmental auditing is an important topic because it has the potential to make a significant contribution to environmental protection. Its also an exciting topic because the field is growing quickly as more and more firms adopt programs.

Most people have at least heard the term environmental auditing before. It is used in the private and public sectors alike. However there is not a shared perception of what exactly environmental auditing is. The objective of this paper is to provide an overview of environmental auditing from a private sector perspective. This understanding is important since environmental auditing is sure to become the subject of increasing industry and government activity.

Topics to be covered in this paper include:

- Description of Environmental Auditing
- Characteristics of EA programs
- Benefits of EA programs
- Potential role of government
- PACE activities

## DESCRIPTION OF ENVIRONMENTAL AUDITING

Simply stated, environmental auditing is a process for self-evaluation of environmental performance. Such programs:

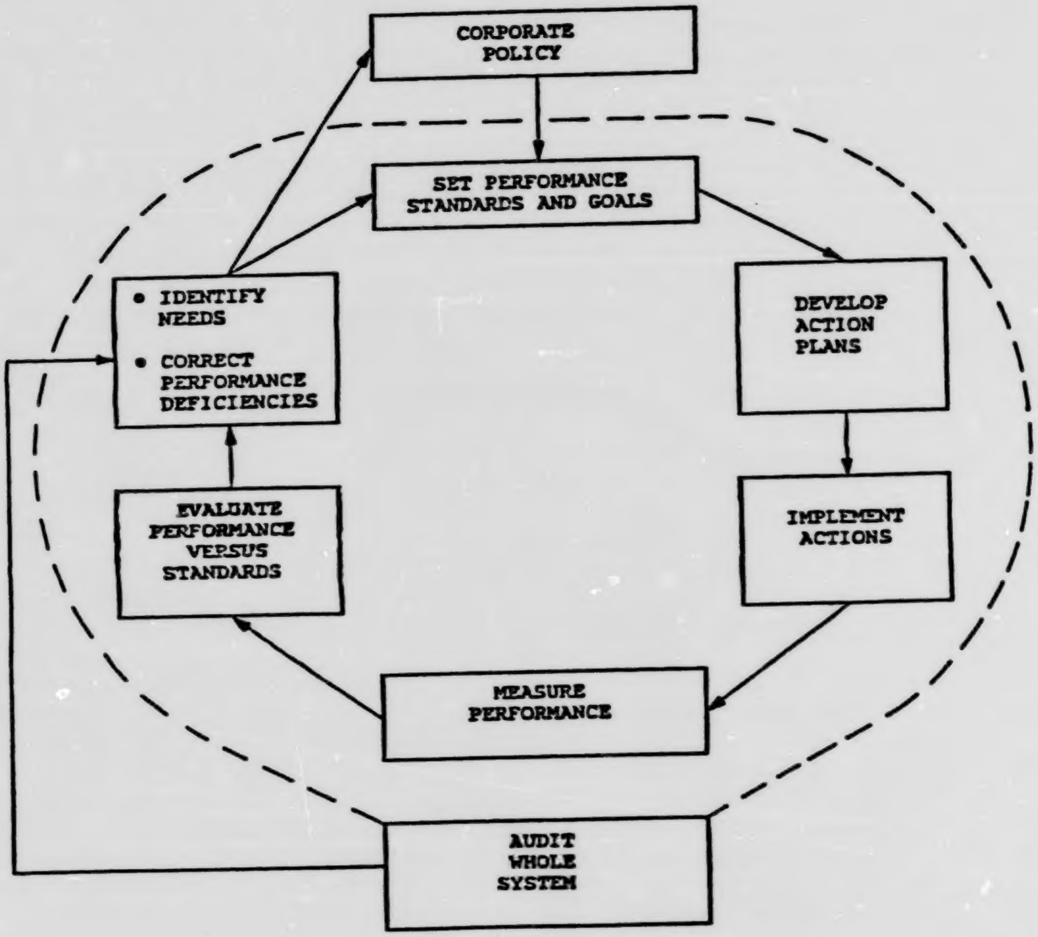
- are internally driven
- are voluntary
- have a formal structure and organizational status
- use rigorous and systematic procedures
- are conducted on a regular cycle, and
- are close-looped.

Environmental Auditing is like any other type of internal auditing. As such, it is a management tool used to monitor performance and detect where problems might arise. Any organization with more than two layers must in some shape or form monitor itself.

Figure 1 illustrates the function of environmental auditing graphically. It shows a general management process that might be used at a large facility of a major corporation.

FIGURE - 1

MANAGEMENT CYCLE


CORPORATE POLICY
SET PERFORMANCE STANDARDS AND GOALS
DEVELOP ACTION PLANS
IMPLEMENT ACTIONS
MEASURE PERFORMANCE
EVALUATE PERFORMANCE VERSUS STANDARDS
● IDENTIFY NEEDS
● CORRECT PERFORMANCE DEFICIENCIES
AUDIT WHOLE SYSTEM

As Figure 1 shows, an environmental auditing is an evaluation of the entire environmental management activity -- each step in the generalized cycle. It is important to note that auditing is not just concerned with end-point performance. Instead, it has the ability to look at the whole spectrum of management activities that lead to or create that end-point performance.

In this respect, environmental auditing is like other types of internal auditing. Consider internal financial auditing: Internal financial audits aren't concerned only with balance sheets and cash flow -- they look at the whole set of practices that lead to sound financial management. Consider internal safety audits: Safety audits aren't concerned only with accident frequency rates and loss time injury rates -- they look at the whole set of systems that create and maintain safe working conditions. And so it is with environmental audits. Same idea; different topic.

It is also important to note that environmental auditing is the check on the system. It is not the system itself. An audit is simply a diagnostic tool. An audit only has value when there is something to diagnose. Too many people fall into the trap of believing that an audit is a panacea, a cure-all, a program that will somehow magically improve environmental management. That is patently false: An audit is just the check; The systems must be present in the first place.

There are three other points to raise in relation to this model.

First, the golden rule for environmental auditors is that they must be independent from the activities that are being audited. If they are not, objectivity and credibility are jeopardized. Normally, this means the audit is conducted by individuals external to the audited facility, such as Head Office personnel, Division personnel or even external consultants.

This doesn't mean that plant personnel can have no role in the audit program as a whole. On the contrary, some of the strongest programs maximize the participation of plant personnel. Such participation takes several forms, including:

- on site liaison
- assistance in designing the program
- participation in decisions regarding audit timing and scheduling.
- and, auditors of other facilities in the company.

Second, a commitment to follow up on audit results is an intrinsic part of any audit program. Follow up refers to actions taken by the company to respond to the findings of the audit in a reasonable fashion and in a reasonable timetable. Sometimes followup procedures are formal, sometimes followup procedures are informal.

Third, an audit is simply one of many, many tools that are available to today's environmental managers. For some companies, it is a good one. But it isn't right for every company. Indeed, it is not needed for every company: Environmental management systems can still be effective without an audit program.

## PROGRAM CHARACTERISTICS

Before describing the characteristics of auditing programs, it is useful to understand what an environmental audit program looks like. A sample audit program might involve the following.

- The corporate environmental department is often given the mandate to conduct audits.
- They assemble a team of experts from within the company (2-6 individuals)
- This team visits the company's major facilities on a regular cycle, for example, every two years.
- The team will spend up to a week on site going over the plant with a fine toothed comb using a set of prepared guides.
- Afterwards, a written report is prepared and distributed to identified people within the company.
- The plant takes corrective action in response to the audit.

Notwithstanding the contents of this "sample" audit program, it is critical to understand that there is a substantial amount of variation among corporate environmental auditing programs. Environmental audit programs are generally tailor-fit to suit the specific needs, resources and culture of the individual firm. Just as each firm is unique, so too is each auditing program.

A number of different characteristics are helpful in describing environmental auditing programs. These include:

- objectives
- scope
- techniques
- program organization
- reporting
- protection of audit information
- follow up, etc.

This paper will focus on the first three only.

### Objectives

The 1984 survey illustrated that companies institute environmental audit programs for a variety of reasons. In fact, some 20 different program objectives were identified. These ranged from

- verifying compliance with regulations, to
- avoiding fines and damage claims, to
- eliminating surprises, to
- enhancing employee awareness to
- improving cost control

Despite this variety of objectives, audit programs tend to have one principal driving force. This driving force is the major determinant of the overall shape of the program. It will affect:

- how it is staffed and resourced,
- what techniques are used,
- which facilities are audited,
- who the findings are reported to, etc.

Audit programs tend to fall into one of two categories. In some audit programs, the principle driving force is to provide assurance to company management that the environmental affairs of the company are being managed appropriately AND that the firm is in compliance with regulations. This is the "comfort factor". Such programs have a heavy emphasis on verification of compliance. The principle client is often the Senior management in the corporation. Some people describe these as "police audits", implying "an over the shoulder", "big brother" kind of approach.

At the other end of the spectrum, we find environmental audits that are primarily intended to provide assistance to line managers. In this mode, the audit is a service to help them improve their management system; in effect, the audit acts as a pair of "fresh eyes" for the facility. Here, the approach is more cooperative, less confrontational. We find a heavy emphasis on assessing the adequacy and effectiveness of environmental protection activities, as opposed to verifying compliance with standards.

In point of fact, most programs tend to blend aspects of both of these approaches. Rarely do they pursue one to the exclusion of the other.

## Scope

Auditing programs also vary tremendously in their scope. There are at least two ways of looking at scope: by subject matter and by function.

Typical audit subject matters include:

- air management
- water management
- waste management
- emergency response and spill control
- hazardous materials
- process units
- health
- external relations, and others.

Some auditing programs are "comprehensive" in their treatment of subject matter. In other words, they look at a full slate of subject matters such as those listed above. Other programs are more "singular" in their approach, looking at only one or two subjects from the full slate. The singular approach allows for a more in-depth analysis of a given subject matter, all other things being equal, whereas the comprehensive approach gives a much wider perspective on plant performance. Both approaches are valid, and both are used by Canadian firms.

Another way of looking at scope is by function. For example, within each specific subject matter, there are a number of parameters to be examined. These include:

- permits and regulatory requirements
- company policies
- operating practices
- management systems
- monitoring and record keeping practices
- training programs
- employee awareness
- equipment maintenance, and others

Some auditing programs choose to focus only on regulatory requirements for each subject matter reviewed. (Some people call these "compliance audits".) Other programs put an emphasis on the management systems and controls that lead to compliance with regulations. (Some people call these "management audits".) Other programs still attempt to look at all aspects of environmental management, including the full list of functions. Virtually all audit programs start out as so-called compliance audits. However, as programs mature, the focus often shifts towards the management systems which underlie compliance.

By combining subject matter and function, it is easy to see that audit programs have a vast range of potential scope, from the

- single subject, single function, to a
- multi-subject, multi-function

## Techniques

Audit programs also vary substantially in the techniques they employ. Essentially, environmental auditing is a process for gathering information. Auditors generally gather information using a blend of three ways:

| | |
|---|---|
| - they look at what goes on | - Observation |
| - they ask a lot of questions | - Inquiry |
| - and, they conduct tests | - Testing |

Audits that are assessment oriented tend to make different use of these techniques than do audits that are verification oriented. Assessment oriented audits emphasize observation and inquiry skills. Observation and inquiry in turn, rely heavily on the professional judgement and communication skills of the auditors. In contrast, verification tends to emphasize testing against known standards or criteria. Testing in turn puts a heavy emphasis on the auditing skills of the auditors.

As for specific tools, auditors carry out their business in a number of ways. For example, they:

- use checklists and questionnaires
- use formal protocols or manuals
- watch people as they work
- conduct interviews with employees
- physically inspect units and facilities
- take photographs
- search through records and files, and, in some cases
- send samples to external labs.

There are many other characteristics to describe auditing programs. But the point is that there is a tremendous variety to this program labelled environmental auditing. The characteristics of programs are unique to each company having been designed to meet the specific management needs, resources, and culture of the implementing firm.

## BENEFITS OF AUDITING

The 1984 survey of Canadian environmental auditing practices conducted by the author indicated that a full 25% of the respondents were conducting auditing programs. The number of firms conducting environmental auditing programs has increased since then. The simple fact is this: Canadian firms are adopting environmental auditing programs on their own. Obviously, there must be some benefits to the process. The benefits of auditing programs generally derive from the product -- i.e. the results -- as well as from the process used to arrive at the product.

The chief benefits include -

1. Measurement of achievement and progress in environmental protection. As an on-going monitoring tool, audits provide a benchmark against which environmental programs can be measured.

2. Substantiated data on compliance with external requirements, company policies and good management practices. A solid data base is critical to effective decision-making; Audits provide a database that can be used by many management levels.

3. Protection against liabilities and proof of due diligence. Audits help to identify weaknesses in the systems that underlie compliance. Audits also provide documentation of due diligence.

4. Identification of risk exposures and early warning of potential problems. As the saying goes - "An ounce of prevention is worth a pound of cure."

5. Improved communications between and within operating facilities. Audits lead to the sharing of information throughout an organization.

6. Education and training. The sheer visibility and process of audits speak volumes to line personnel.

Clearly, audits are instituted for sound business reasons. But there is an added plus. Audits can result in a better level of protection for the environment.

## GOVERNMENT ROLE

The positions that are expressed in this section are the author's and should not be interpreted as a formal PACE position. PACE has not, as an Association, developed a formal policy position with respect to environmental auditing.

Because audits are good for firms and for the environment, I believe the government, should, if anything, adopt a supportive role for auditing. A supportive role can be garnered through:

- sponsoring conferences and workshops
- providing technical assistance to firms who want to learn about programs
- publicly endorse firms with programs
- and other activities that encourage the spread of voluntary auditing.

The 1984 study of Canadian industry identified a strong level of support for this type of government role.

I do not believe however, that the government should go as far as to require environmental auditing, whether that requirement is in the form of a regulation, a policy, or even an attitude. This is because the minute an audit is required, the nature of the beast is changed. It is no longer a voluntary program suited to the management needs of the firm, but a regulatory requirement. And all the innovation and commitment that is so characteristic of voluntary programs will be lost.

The U.S. EPA looked at requiring audits, and decided not to. As a regulatory agency, they felt they had neither the expertise to develop, nor the resources to maintain, a mandatory auditing program.

I believe it is important for the Department of the Environment to develop and communicate a policy on how to treat existing audit programs. Developing such a policy is no simple task, but I do believe it is important that industry and government work together in this regard.

## PACE ACTIVITIES

PACE is a national, non-profit, technical organization composed of

- Esso
- Husky Oil
- Petro-Canada
- Petrosar
- Shell
- Suncor
- Texaco
- Ultramar

PACE is a leader in the area of environmental auditing, as well as many other environmental endeavours.

In 1984, PACE sponsored a workshop for its members to learn about auditing, and encourage use of the practice.

More recently, PACE has been working with the federal government, and other industry associations, in developing educational materials on auditing

- one is a video-tape
- the other is a planned national conference

The most recent PACE project is the PACE Environmental Performance Measures project. This project when completed will provide PACE members with an important tool to use as part of internal auditing programs.

## CONCLUSION

Since its earliest application, the goals and functions of audit programs have expanded considerably. It is no longer restricted to measuring compliance and monitoring performance. It is used effectively as a tool for line management, education training and communication. As such, it has tremendous potential to make valuable contribution to protection of the environment.

JWR:sb
4/aud1

# LIABILITY FOR HANDLERS OF HAZARDOUS WASTE

Jillian Flett
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## I. INTRODUCTION

I appreciate the opportunity to meet with you and discuss the potential liability for spill clean up and victim compensation faced by handlers of hazardous wastes. As a result of major spills of dangerous goods, including the Mississauga train derailment and the P.C.B. spill near Kenora, there has been an increased public awareness of the potential problems associated with handling dangerous goods which has been reflected in the legislation. The law in this area can be vague and liability can vary to a large extent, depending on the fact situation and the province wherein the event took place. Therefore, this presentation only provides a general overview of some issues associated with both statutory and common law liability for spill clean up and compensation of victims of hazardous wastes spills. It is not intended to be a legal opinion.

I would like to focus on three main areas:

1. the responsibilities outlined in Alberta legislation for handlers of hazardous wastes in the event of a spill and some available defenses.
2. the legal actions available to victims of hazardous waste spills and some of the limitations of these actions in providing full compensation.
3. the approach followed by Ontario to overcome some of the issues associated with victim compensation and spill clean-up.

## II. OVERVIEW OF STATUTORY RESPONSIBILITIES

I will focus my comments on the three main Acts in Alberta dealing with liability for transportation and disposal of hazardous wastes, the federal *Transportation of Dangerous Goods Act*[1] (T.D.G.A.), the Alberta *Transportation of Dangerous Goods Control Act* (T.D.G.C.A.)[2] and the Alberta *Hazardous Chemicals Act.*[3]

The federal and Alberta transportation of dangerous goods legislation are very similar in that they both impose duties on manufactures, transporters and consignees. These duties deal with: safety marks and labels, training of personnel handling dangerous goods, developing an emergency response plan, reporting spills of dangerous goods and taking reasonable emergency measures to repair any dangerous condition as the result of a spill.

### A. Liability for Spill Clean-up

Both the federal and provincial transportation of dangerous goods legislation impose a duty to report a spill of dangerous goods[4] and to take reasonable emergency measures to repair any dangerous condition as the result of a spill.[5] This duty is imposed on the "persons who at the time have the charge, management or control of the dangerous goods."

Neither Act defines what is meant by "charge, management or control" thereby giving rise to concern that liability attaches to the owner of the hazardous wastes. As a result, generators of hazardous wastes may try to transfer title to the wastes as soon as possible thereby avoiding liability on the basis of ownership. Although the extent of liability could possibly be reduced by transferring title and thereby showing intent to relinquish "charge, management or control", ownership itself does not determine liability.

The meaning of "charge, management and control" as used in this Act has yet to be interpreted by the Courts. However, in the case of *Kirk* v. *McLaughlin Coal Supplies Ltd.*,[6] the Ontario Court of Appeal found that "control" did not necessarily mean physical custody or ownership, although those factors could be considered in determining control. The court found that the person responsible for maintenance and servicing was the person in "control" of the item. As a result, it is possible that the generator of hazardous wastes could be liable for damages for hazardous waste leaking from a container if he was the person responsible for servicing and maintaining the container. He could be liable if the container sprung a leak while being transported or while at the purchaser's yard even though he was not the owner and did not have physical possession of the container. This liability would not apply to situations where the spill was the result of an intervening act of a third party.

The *Hazardous Chemicals Act* also imposes an obligation on the person responsible for hazardous wastes to take all emergency measures consistent with public safety to repair, remedy, confine the effects of and remove the hazardous chemical. However, this liability is limited to a spill at a facility for the storage, treatment or disposal of a hazardous chemical.[7]

Again, this Act goes beyond ownership when imposing liability on the "person responsible". In this Act, "person responsible" means "the owner; the person having the charge, management or control of the hazardous chemical; and the person having the charge, management or control of the handling, storage, use, disposal, transportation or display of it".[8]

In addition to the potential liability of generators on the basis of the interpretation of "control", there is also a potential liability imposed under s.8 of the Hazardous Chemicals Act which states that

> " every person is, with respect to any matter under this Act and the regulations, responsible for ...b) the use or operation of any aircraft, vehicle, equipment or machinery used for or in connection with any matter under this Act with his knowledge or consent, whether express or implied."

This provision could be interpreted to make the generator and transporter of hazardous wastes responsible for spills resulting from the operation of a vehicle transporting hazardous wastes originating from the generator's facility.

Both the federal and Alberta transportation of dangerous goods Acts contain provisions allowing an inspector to require any person he considers qualified to take remedial action in an emergency situation even if that person is not responsible for the dangerous goods and therefore is not required to clean up under the other provisions of the Acts.[9] That person will not be found personally liable unless he acts unreasonably in the circumstances.[10]

Liability under all three Acts is limited to clean-up of the spill and does not require restoration of the environment to its former state.

### B. Contracts of Indemnity

It is of note that the T.D.G.A provides that all parties are jointly and severally liable.[11] As a result, the generator, owner or transporter of the hazardous waste could be jointly liable in the event of a spill. Under the Alberta Contributory Negligence Act[12] if more than one party is at fault, as between themselves, they are liable to indemnify each other according to the degree in which they are at fault, unless there is a contract stating otherwise.[13]

Contractual obligations relating to liability between shippers and carriers are outlined in the Bill of Lading. However, this does not deal with the issue of liability to third parties.

Generators of hazardous wastes could reduce their financial responsibility to third parties by entering into contracts with purchasers or transporters for contribution or indemnity in the event they are found liable for clean-up or compensation costs. Prior to entering into these agreements all parties should be aware of the nature of the waste and the hazards involved in its handling.

Although contracts of indemnity could help reduce potential liability to third parties, they could also lead to practical problems for generators and transporters. It may be difficult for generators to find transporters that have complied with all the statutory requirements that are willing to accept this liability. Problems could also arise for small transport companies that are forced to bear the liability so that large hazardous waste generators will continue to deal with them. Suggestions that there may be a need for legislation to restrain the right of a person who profits from dealing with dangerous goods from contracting out of their compensation liability.

C. Liability for Acts of Employees and Agents

Under the T.D.G.A. corporations are liable for the acts of their employees or agents unless the offense was committed without their knowledge and all measures were taken to prevent its commission.[15] A similar provision exists in the Hazardous Chemicals Act wherein every person is liable for acts and omissions of employees and agents.[16] However, this liability is limited to those acts and omissions within the scope of their actual or apparent authority.

D. Director's Liability

The T.D.G.A. further makes directors, officers and agents who directed, authorized, assented, acquiesced or participated in the commission of an offense, liable even if the corporation is not prosecuted.[17] This provision helps to overcome the use of shell companies which have no assets to avoid paying clean up costs.

E. Defenses

The T.D.G.A. and the T.D.G.C.A. allow for the defense of due diligence.[18] Once the Crown has proved beyond a reasonable doubt that the offense occurred, the defendant can avoid liability by showing that it did everything reasonably possible to prevent the offense from occurring. Although the Hazardous Chemicals Act does not have a similar provision, there is case law which establishes that these types of offenses are considered to be strict liability offenses and as such, the accused may raise the defense of reasonable care even if it is not mentioned in the legislation.[19]

In order to rely on this defense, the corporation should have established a system for selecting, training and supervising its employees and agents involved in the handling of hazardous wastes. It should also be able to show the establishment of a good communications system, frequent inspections, adequate design and maintenance of facilities and back-up systems in the inevitable event of human error.

It is possible for the corporation to raise this defense even if its employees were negligent.[20] However, the corporation can not avoid the duty of reasonable care by simply contracting out work or saying that the controlling mind or will of the company was delegated to someone else. Therefore, time and money spent on establishing the above systems would appear to be worthwhile.

## III. Overview of Civil Liability

Despite legislation to regulate the handling of hazardous wastes, accidents do happen and situations will arise resulting in environmental damage or human injury. Liability to compensate individuals for property damage or personal injury may arise even though the person responsible for the spill complied with all the legislative requirements and took due care. This leads to the question of whether pollution is an inevitable consequence of society's activities for which everyone benefits or if it is a wrong for which the perpetrator should be liable? Should society or the polluter pay?

Although the legislation in Alberta establishes a duty to clean up a spill, it does not specifically deal with the issue of compensating victims for losses suffered as a result of the spill. It is left to the civil courts to determine whether or not the polluter should compensate a spill victim. Even in those situations where the courts determine that the polluter should pay, the victim may remain uncompensated if the polluter has no assets. This differs from the situation in Ontario which has established a fund to compensate victims of a spill in the event they are unable to claim from the polluter. In this way society, not the victim, bears the cost of the spill. This system will be discussed in further detail in part IV.

### A. Potential Problems Faced by Victims of Spills

Before a victim of a hazardous waste spill can obtain compensation, he must overcome a number of hurdles associated with proving a causal connection between his injury and the exposure to the hazardous waste. The lack of scientific evidence about the direct correlation between the exposure to the toxic substance and health effects have restricted the availability of civil actions for compensation. However, courts have recognized this difficulty and reduced the standard of proof in situations involving claims for personal injury arising from exposure to a hazardous substance over a prolonged period of time. In these situations the courts have held that the plaintiff can recover damages merely by proving that the exposure to the hazardous substance occurred because of the defendant's act or omission and that such exposure "materially increased the risk" of the plaintiff's injury.[21] For example, if a plaintiff was exposed to a substance that leaked from a landfill over a long period of time, he need only prove that exposure to that substance increased the risk of his health problem not that it was the direct cause.

Even if the cause and effect can be proved, a further problem may arise in trying to prove who is responsible for the exposure.

Another problem faced by victims of hazardous waste spills is that injuries may not become evident until after the limitation period for bringing the action has passed. In considering the issue of when limitations periods begin, the Supreme Court of Canada has recently held that limitation periods begin when the material factors on which the action is based have been discovered or ought to have been discovered by the plaintiff with the exercise of reasonable diligence.[22] This prevents the situation of plaintiffs being unable to obtain compensation because they discovered the correlation between exposure to a hazardous substance and a health effect after the limitation period had expired.

The system can also be potentially unfair to generators or disposers of hazardous waste if they are found liable for environmental or health impacts after having used an accepted disposal practice or an accepted hazardous waste producing substance for years. Even if the cost of the liability is passed on the the consumers of the product, it is difficult for the company to estimate the potential liability they may be facing in order to assess these costs.

It is also difficult to make industry pay for their past disposal practices if they used the best available techniques at the time.

If a victim commences legal action for compensation he must fit his claim into a number of overlapping and varying causes of action each with its own criteria for eligibility and its own defenses. The person responsible for the spill may face a legal action for compensation under any one of a number of existing causes of action including: trespass, nuisance, negligence and Rylands v. Fletcher. Because of the overlap, lawyers often claim under more than one cause of action. The following are examples of how these causes of action could be used to obtain compensation for injuries arising from a hazardous waste spill from a truck or a leak from a landfill site.

### B. Trespass

A cause of action in trespass arises as a result of an intentional interference with land. This action requires that the plaintiff prove direct interference. It is best used in situations where damages are difficult to determine because in trespass, the plaintiff need not prove material loss only interference with land. This cause of action could only be used by owners or occupiers of land to ensure clean up of unwanted substances that were intentionally deposited on their land. Therefore, it would likely be of little value in the situation of accidental spills during transport of hazardous wastes or leaking of hazardous wastes from a landfill.

### C. Nuisance

A nuisance action may arise in the event of physical injury to land or substantial interference with the use and enjoyment of property. A nuisance action could apply to a single incident, such as a truck spilling hazardous waste on a farmer's field; or a continuing incident, such as hazardous wastes leaking from a landfill site.

The plaintiff may be an owner or a tenant of the land where the waste spilled and the defendant may be an owner, or operator of the landfill or truck. However, each must have knowledge of the interference.[23] An owner may be vicariously responsible for the acts of employees and in some cases, independent contractors. However, a defendant is only liable for foreseeable damages or if he should have known that the injury was foreseeable.

For example if a leaking disposal site is being actively used, the plaintiff must show that the defendant had created or continued the condition causing the nuisance knowing the harm to the plaintiff's interest was substantially certain.[24]

A person may be liable in nuisance even though they have done nothing illegal or if the nuisance was created as a result of providing a service for the public good (for example a municipal landfill). In the case of Buysse v. Shelburne,[25] a municipality was found liable in nuisance when the pumps at the municipal pumping station malfunctioned causing sewage backup in the plaintiff's house. The municipality raised the defense that the enterprise was necessary and socially essential. However, the court refused to accept that benefit to the public at large was a defense to actual physical damage to plaintiff. It is possible a similar defense by a municipality or industry in the event of a leaking landfill site would also prove unsuccessful.

The defense of statutory authority can be successfully raised in a nuisance action if the defendant can prove that the nuisance was the inevitable consequence of the authorized undertaking. In the Buysse case the court did not find that the damage was the inevitable consequence of the operation of the sewage facility and therefore, the defendant was unsuccessful in this defense.

The following are some commonly raised defenses in a nuisance action which will not be accepted by the courts:

1. that the plaintiff came to the nuisance. For example a defendant will be unsuccessful in claiming that the landfill was leaking prior to the plaintiff's arrival and that by locating nearby the plaintiff acquiesced to the leaking.

2. that there is no other place available for the site. For example a defendant cannot avoid liability by stating that the landfill could not be located elsewhere

3. that all reasonable care and skill was taken to prevent the nuisance. Although the defense of reasonable care could be successful in a criminal action for violating a statute, it would not be successful in a nuisance action wherein a plaintiff is claiming damages for losses suffered as a result of a spill. For example, a defense based on the fact that the driver of the truck that spilled the hazardous waste was well trained and had been driving carefully will not avoid liability in a nuisance action.

4. that the use of the property was reasonable. For example it is no defense that a landfill was the only reasonable use for the land.

## D. Negligence

To be successful in a negligence action the plaintiff must prove that:

a. the defendant owed a duty of care to the plaintiff,
b. the defendant's conduct breached the required duty of care and as a result the plaintiff suffered damages, and
c. the damages suffered by the plaintiff were foreseeable.

The standard of care imposed by the court on handlers of hazardous wastes will be higher than that for handlers of non-hazardous wastes.

It is of note that the fact that the defendant violated a statute does not of itself give a plaintiff the right to compensation in negligence. The Supreme Court of Canada has held that the violation of a statute does not give rise to a civil action, although it may be used as evidence of a reasonable standard of care.[27]

The law of negligence has been used successfully to obtain compensation for injuries suffered as the result of a leak from a landfill. In the case of Gertsen v. Metro Toronto[28] the defendants were held liable in negligence for damages arising as a result of burying garbage that they knew or should have known would produce methane gas. The defendants were also negligent in failing to prevent the escape of the gas and failing to warn the adjoining owners of the risk of escape.

The defendant's liability in a negligence action can be reduce if the plaintiff's actions contributed to his injuries.

## E. The Doctrine of Rylands v. Fletcher

The owner or occupier of property will be liable regardless of whether he is negligent, for damages caused by any dangerous thing which he brings onto his land for a non-natural use if the dangerous thing subsequently escapes. There are only a few available defenses including: acts of God, intervening acts of third parties and the consent of the plaintiff.

This cause of action usually applies to situations where dangerous substances leak from one property to another. For example, it is possible that this cause of action could be used to obtain compensation for damage caused by hazardous wastes leaking from a landfill site onto neighbouring property. The defendant need not be the owner or occupant of the land from which the dangerous substance escapes, but he must be the person in control of the dangerous thing and he must have brought it onto the land. In situations where the landowner is unaware of the hazardous waste on his property, it is unlikely they will be found liable under this doctrine if it is later found to be leaking.

Although this cause of action has also been used to find a transporter of a dangerous substance which spilled during transport liable for damages caused as a result of the spill,[29] it is more likely that a nuisance or negligence action would be brought in situations involving transportation spills.

The disadvantage of using a Rylands v. Fletcher cause of action is that the plaintiff must prove that the use of land is not natural. It may be difficult to determine what constitutes a natural use. The courts have used words such as "extraordinary, exceptional and abnormal" in determining whether something is unnatural. For example, the Ontario High Court in the case of *Gertsen* v. *Municipality of Toronto*[30] held that a landfill was an unnatural use of land in a heavily populated residential district. While in the case of *North York* v. *Kert Chemical Industries Inc.*,[31] the Ontario High Court stated that the "use of land in an industrial subdivision for the manufacture and processing of cleaners requiring the use of chemicals may not be an unnatural use of land".[32] This recognizes society's increasing use of sophisticated technology as "natural" depending on its location, even though it may be inherently dangerous. As a result, enterprises which are operated reasonably in an industrial area may be considered as a natural use of land and therefore, not be liable under this doctrine.

## IV.OTHER COMPENSATION SYSTEMS

Ontario has attempted to deal with some of the problems resulting from relying on the common law for spill clean up and victim compensation. They have moved towards the philosophy that pollution is an inevitable social problem and therefore, society as a whole should bear the cost. This concept is reflected in Part IX of the Ontario *Environmental Protection Act*,[33] the so-called "Spills Bill". It was developed to ensure prompt clean up of spills and to prevent situations where parties are hesitant to clean up spills because it might be considered an admission of common law liability. It also provides for new civil liability for clean up costs and broadens the damages which may be recovered. Finally, it provides for limited compensation from the government for certain clean up costs and certain damages.

The Act imposes absolute liability for clean up of spills thereby, providing no defense and removing the issue of fault. The owner and the person having control of the pollutant are liable regardless of the fact that they did everything possible to prevent the spill from occurring. The Act also requires that they do everything practicable (ie. within their technical, physical and financial resources) to clean up a spill and restore the environment.[34]

The Act provides for strict, as opposed to, absolute, liability for direct losses such as physical or economic loss and loss of enjoyment of land.[35] This means that liability can be avoided by proving that everything reasonable was done to prevent the spill. However, this defense is only available for claims for physical injury, economic loss or loss of enjoyment of property. It is not available to avoid liability for costs associated with spill clean up.[36]

Although the Act imposes liability on owners and persons responsible for a pollutant beyond that imposed by common law, this is offset by allowing them to recover from the Environmental Compensation Corporation for the additional liability. They can only recover if they were not liable at common law.[37] For example, they could not recover if they had been negligent. In this way, the Act attempts to encourage clean up and compensation by having the additional burden borne partially by the state. However, the provisions for compensation are limited in that there is a specified deductible that must be paid before collecting from the fund and claims over a set amount must be approved by the Lieutenant Governor in Council.

It also provides for the recovery of damages for economic loss in situations where there is no physical or property damage.[38] For example if a truck spills hazardous wastes on a farmer's field, at common law the owner of the truck would be liable for the cost of the clean up and direct loss or damage to the owner of the land. A farm worker who lost income as a result of the spill but was not physically injured would be unable to recover. Under the Spills Bill, a farm worker who lost income as a result of the spill can recover even if he did not suffer any physical injury.

Victims of pollution spills may receive compensation from the Fund after having brought legal action to attempt to recover from those parties responsible for the spill. This ensures that the victim will be compensated even if the person responsible has no assets. However, legal action is unnecessary if the victim does not claim more than a specified amount or if waived by the Environmental Compensation Corporation.[39]

## V. SUMMARY

In summary, because of the minimal amount of case law in this area, this presentation has only provided a general overview of the potential liability faced by handlers of hazardous wastes. Although it is difficult to clarify the extent of liability, an indication of the potential statutory and civil liability has been discussed. Possible defenses available to those facing liability for hazardous wastes spills are also discussed. Some problems associated with the common law system for compensating victims of hazardous waste spills have been raised as well as some comments about how Ontario has dealt with some of these problems in their legislation.

The information in this presentation is not intended to be a legal opinion and it is recommended that a legal opinion be sought regarding liability prior to becoming involved in legal proceedings associated with hazardous waste spills.

## FOOTNOTES

1. S.C. 1980-81-82-83 c.36 as.am.
2. S.A. 1982 c.T-6.5
3. R.S.A. 1980 c.H-3 as.am.
4. Supra note #1 s.17(1) and supra footnote #2 s.10(1)
5. Supra note #1 s.17(2) and supra footnote #2 s.10(2)
6. 66 D.L.R. 321
7. Supra note #3 s.7.1
8. Ibid s.1(j)
9. Supra note #1 s.17(3) and supra footnote #2 s.10(3)
10. Supra note #1 s.17(5)
11. s.18
12. R.S.A.1980 c. C-23
13. Ibid s.2
14. Swaigen, J. "Compensation of Pollution Victims in Canada" P.20
15. s.10
16. s.8(a)
17. s.11
18. Supra note #1 s.8 and supra footnote #2 s.21
19. R. v. City of Sault St. Marie (1978) 85 D.L.R. (3d) 161
20. Aurora Quarrying v. Catherwood (1982) 6 W.W.R. 517
21. McGhee v. National Coal Board (1972) 3 All E.R. 1008
22. Central Trust v. Rafuse (1987) 31 D.L.R. (3d) 9
23. Harbell, J. "Common Law Liability for Spills" P.4
24. Makuch, S.M., P.G. Murray "The Spills Bill: Specific Problems" P.63
25. (1984) 45 O.R. 501
26. Supra note #22 P.11
27. R. v. Saskatchewan Wheat Pool (1983) 143 D.L.R. (3d) 9
28. (1974) 2 O.R. 1
29. Dokuchia v. Domansch (1945) O.R. 141
30. Supra note # 28
31. (1985) 33 C.C.L.T. 184
32. Ibid P.200
33. R.S.O. 1980 c.131
34. Ibid s.81
35. Ibid s.87(3)
36. Ibid s.87(6)
37. Ibid s.91
38. Ibid s.87(1)
39. Estrin, D." Handle With Caution: Liability in the Production, Transportation and Disposal of Dangerous Substances" P.210

# RISK MANAGEMENT AND RESPONSIBILITY

Tricil

M. Nigel Guilford

Paper unavailable at time of printing

# A SYSTEM BORN OF CRISIS:

# HAZARDOUS WASTE MANAGEMENT AND CLEANUP IN THE UNITED STATES*

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This paper will analyze certain aspects of the U.S. experience with hazardous waste management and cleanup and place that experience in a practical context for Canadian environmental planners. Three areas will be emphasized: (1) the principal elements of the hazardous waste management and cleanup system established by the U.S. Congress; (2) the points at which that system has malfunctioned; and (3) the current quest for a more effective approach.

At the outset, it is important to recognize that the cumbersome statutory permitting and liability scheme is not the sole explanation for the nation's problems in achieving state-of-the-art waste management practices and site cleanups. The statutes discussed below and the political agendas which hamper their implementation tell only half the story. The other half pertains to liabilities arising under the common law, i.e., the principles that afford private parties compensation for harms arising from exposure to hazardous waste or substances. These harms, in the form of personal injury or property damage, are known as "toxic torts". This paper will focus on statutory issues, but the role played by toxic tort principles in complicating the picture is noted in parts II and III.

## I. SUMMARY OF KEY FEDERAL HAZARDOUS WASTE LAWS

Two federal statutes establish mechanisms for cleaning up properties contaminated by hazardous waste or hazardous substances: the Resource Conservation and Recovery Act ("RCRA") and the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA" or "Superfund").1/ RCRA's primary purpose is to prevent hazardous waste releases by controlling and tracking the waste from generation to disposal and thereafter (the "cradle to grave" philosophy). RCRA authorizes the government to compel site cleanups in two situations: where a site's condition endangers health or the environment and where a contaminated site is subject to RCRA's permit requirements.

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* Copyright © 1987 by Jennifer L. Machlin. Substantial portions of this paper will appear in a forthcoming book. A table of the abbreviations used in this paper, and the footnotes, follow the text.

CERCLA's primary purpose is to remedy contamination caused by any "hazardous substance" (a term which includes hazardous waste), by providing for identification of problem sites, application of rigorous cleanup standards, and cleanup funding. These statutes are closely interrelated, and Congress reinforced that relationship by requiring in the 1986 CERCLA amendments that CERCLA cleanups must conform to applicable RCRA waste management standards.

Although RCRA and CERCLA were intended to provide a unified program for hazardous waste management and contamination cleanup, two major obstacles to such a program have arisen. The first obstacle is the government's ponderous and piecemeal approach to implementation of these laws. The second is the widespread use of litigation in response to disputes about responsibility for cleanup and related issues, with a corresponding increase in transactional costs and cleanup delays. The summary that follows is intended to highlight the legal framework within which these problems have emerged; it is not intended as a full explication of RCRA or CERCLA and should not be viewed as such. With regard to RCRA, some of the issues which have created confusion and complexity for the regulated community, including elaborate permitting requirements and enforcement mechanisms, are briefly addressed. The CERCLA discussion emphasizes the statute's approach to cleanup liability and cleanup standards, as reinforced by the recent 1986 amendments.

### A. RCRA's Waste Tracking and Permit Requirements

In accordance with the "cradle-to-grave" principle, RCRA establishes requirements to govern all those who deal with the waste at some point during its life span. These hazardous waste handlers fall in four broad categories: those whose operations create the waste ("generators"), those who ship the waste from its place of origin to some other destination ("transporters"), those who own or operate hazardous waste management facilities ("treatment, storage, or disposal facilities," or "TSDFs"), and those who sell or burn hazardous waste or used oil as fuel. RCRA's coverage is not confined to hazardous waste management, however. The statute also governs underground tank storage of substances other than hazardous waste and the disposal of "nonhazardous" solid waste.

The federal agency charged with shaping RCRA's hazardous waste management program is the Environmental Protection Agency ("EPA"). EPA, in an effort to guarantee proper handling of hazardous waste, has developed sweeping and complex regulations applicable to the hazardous waste handlers identified above. These regulations establish, among other requirements, the standards for issuance of permits to hazardous waste treatment, storage, and disposal facilities.

1. State Involvement in RCRA's Hazardous and Nonhazardous Waste Management Programs. While EPA has primary responsibility for implementing the RCRA programs which apply to hazardous waste management and underground storage tanks, states may be authorized to carry out those programs. To obtain authorization, states must adopt standards that are as least as stringent as EPA's; they may impose more stringent standards.2/ States do not require EPA authorization to implement RCRA's nonhazardous solid waste disposal program, by contrast, because RCRA affords them primary responsibility for managing such waste.3/ RCRA does empower EPA to adopt nonhazardous solid waste management criteria, however, and state permitting programs must incorporate those criteria.

EPA's requirements for waste handlers and underground tanks are outlined below. These federal regulations, it must be emphasized, establish the minimum standards for acceptable state programs, and many states have adopted regulations which impose broader and more rigorous requirements. Thus, on a national basis, solid waste management is subject to a patchwork of overlapping federal, state, and local programs.

2. Identifying a Waste as "Solid" and "Hazardous". EPA requires any person who generates "solid waste" to determine whether it is "hazardous." If a waste is both solid and hazardous, it becomes subject to the whole panoply of RCRA regulations, unless a statutory or regulatory exception applies.4/ These two inquiries -- is the waste "solid"? if so, is it "hazardous"? -- must be made by reference to a series of complex definitions, lists, and technical standards established by EPA. EPA's waste analysis approach may be summarized as follows.

A "solid waste" is any material (even a liquid) that is "abandoned," "recycled," or considered "inherently wastelike."5/ Under this definition, the vast majority of wastes generated by industrial or manufacturing processes are "solid" and hence must be evaluated to see whether they are hazardous. That determination rests on (1) regulatory hazardous waste lists (compiled by EPA; a state authorized to manage the RCRA program may have a more comprehensive list), (2) tests for specified characteristics (*e.g.*, the waste's "ignitability"), (3) regulatory "mixture" definitions, and (4) regulatory exclusions.

If a generator determines that he produces a hazardous waste (or wastes) and that his monthly hazardous waste output totals 1000 kilograms or more, he is subject to the requirements outlined below. Separate rules govern generators who produce lesser amounts of hazardous waste ("small quantity generators").

3. Generator Requirements: Manifests, Recordkeeping, and Waste Minimization. At a minimum, under EPA's regulations, a hazardous waste generator must take the following steps to avoid possible enforcement action: (1) register with EPA as a generator and obtain from EPA a generator identification number; (2) label and contain the waste in accordance with EPA's short-term storage requirements, prior to pick-up for offsite disposal; (3) prepare and label waste for transport in accordance with EPA's requirements; (4) ensure that each waste shipment is accompanied by a properly completed and signed EPA manifest, certifying to the adoption of a "waste minimization" program to the extent "economically practicable"; (5) report waste shipments biennially to EPA; and (6) keep on file for three years copies of manifests, biennial reports, and waste analyses.6/

If a generator not only produces hazardous waste but also manages it on-site (e.g., through treatment or disposal of the waste or storage in excess of 90 days), the generator is subject to the facility permitting requirements outlined in section 5 below. Individual states, as noted above, may impose more rigorous standards on generators.

If a generator produces less than 100 kilograms of hazardous waste a month, he is exempt from RCRA under EPA's regulations (although some states have no small quantity exemptions). If his monthly output is between 100 and 999 kilograms, however, he is a "small quantity generator" ("SQG") and must take the following steps: (1) obtain an EPA identification number, (2) use EPA's manifest when shipping waste, (3) conform to EPA's generator packaging and labeling standards, and (4) conform to EPA's generator recordkeeping requirements. Thus, SQGs are subject to most of the generator requirements. An important distinction, however, is that SQGs, unlike full-fledged generators, may store up to 6000 kilograms of waste onsite for up to 180 days without a RCRA permit (if provision is made for an emergency involving the waste). If the waste is to be shipped over 200 miles, the maximum unpermitted storage period increases to 270 days.7/

4. Transporter Requirements. Certain hazardous waste transporter requirements parallel those for generators. Transporters must obtain an EPA identification number and cannot ship waste without a manifest signed by the generator (which the transporter also signs and dates). In addition, the transporter must deliver each generator's waste shipment in its entirety to the facility or transporter designated by the generator to receive it or, if an emergency prevents such delivery, to the designated alternate. The transporter must obtain the

recipient's dated signature on the manifest, return it to the generator, and keep a copy for three years from the acceptance date.8/

Under EPA's regulations, transporters may store a hazardous waste shipment at a "transfer facility" for under 10 days without a RCRA permit.9/ Here again, however, state regulations may require a permit.

In the event of a hazardous waste spill while in transit, transporters are required to take "immediate action" to protect human health and the environment. Such action may include notification to local and federal authorities. In addition, the transporter must either clean up the spill or take steps as required or approved by government officials to remove any hazard to human health or the environment created by the spill.10/

5. Treatment, Storage, and Disposal Facilities (TSDFs). EPA imposes complex and rigorous design and performance standards on facilities which treat, store, or dispose of hazardous waste. Such facilities must obtain RCRA permits; the permitting procedures differ, however, for TSDFs which were in place or under construction on or before November 19, 1980 ("existing facilities") and those which commenced operation or construction after that date ("new facilities").

a. Requirements for Existing TSDFs. Many of the requirements applicable to existing facilities are virtually identical to those imposed on new facilities and thus have required existing TSDFs to undertake extensive retrofitting measures. RCRA expressly mandates, moreover, that existing landfills, surface impoundments, land treatment units, and waste piles which receive hazardous waste after July 26, 1982 comply with the "new facility standards" for groundwater monitoring, unsaturated zone monitoring, and "corrective action" as to any hazardous waste release.11/ In addition to these facility design and operating requirements, existing TSDFs must comply with manifesting, recordkeeping, and reporting requirements.12/ Moreover, they must provide to EPA or authorized states adequate evidence of their financial capability to shut down the facility in accordance with EPA's "closure" requirements and monitor for possible contamination during an extended "post-closure" period.13/

b. Site Cleanup As A Permit Requirement ("Corrective Action"). An existing TSDF which has experienced a hazardous waste release from a "solid waste management unit" must agree to remedy the release, in order to obtain a RCRA permit allowing it to continue its waste management activities.14/ A solid waste management unit is any part of a TSDF at which solid waste is processed, recovered, disposed of, or otherwise handled.15/ Thus, a TSDF owner or operator seeking a permit must clean up contamination caused by the facility, whether or not that person was operating the facility when the waste in question was placed there.

If corrective action cannot be completed before EPA issues a permit to a TSDF with a release problem, the permit must include corrective action schedules and adequate guarantees that the permit holder is financially capable of completing the action.16/ This requirement may extend to cleanup of contamination beyond the TSDF boundary.17/

c. Requirements for New TSDFs. New TSDFs may not commence construction until they have obtained their RCRA permits. This process may be extremely time-consuming, since EPA's design and performance standards for most TSDFs are complex and rigorous. EPA therefore requires submission of the permit application at least 180 days before construction is scheduled to begin.18/

In addition to the design and performance standards, new TSDFs, like existing facilities, also are subject to manifest, recordkeeping, monitoring, and closure requirements.19/ All these factors make it difficult, costly, and time-consuming for hazardous waste generators to obtain permits that would enable them to treat, store, or dispose of their own waste at their own facility ("on-site"). For that reason, even though off-site TSDFs often charge substantial fees to generators and shipping waste off-site can give rise to significant liabilities, relatively few companies are likely to opt for on-site management.

d. Land Disposal Ban. TSDFs include facilities for the land disposal of hazardous waste. In response to increasing concern that not even state-of-the-art landfill facilities can safely contain hazardous waste for long periods, Congress in the 1984 RCRA amendments prohibited land disposal of the following untreated hazardous wastes after specified deadlines: certain liquid hazardous wastes, certain dioxin containing wastes, and certain solvent wastes.20/ The prohibition may be lifted only if EPA deems it unnecessary to protect human health and the environment for as long as the waste remains hazardous.21/ Due to a nationwide lack of treatment capacity for these wastes (in particular, a lack of incinerators which meet EPA's treatment standards), EPA has taken steps to postpone the land disposal ban. Individual states, however, may put the ban into effect earlier, depending on their available treatment capabilities.

6. Hazardous Waste and Recycled Oil as Fuel. The 1984 RCRA amendments required EPA to regulate those who make hazardous

waste into fuel, burn any fuel made from or containing hazardous waste, or market any such fuel. By February 8, 1986, those who produced, used, distributed, or marketed such fuel were required to notify EPA of their activities, including a description of the facility, the waste(s) involved, and the fuel production or energy recovery process (if any).22/ The amendments also call for EPA regulation of those who generate and transport recycled used oil and those who produce, use, and market hazardous waste as fuel.23/ EPA originally proposed to list recycled used oil as a hazardous waste, but ultimately decided to postpone such listing. Whether used oil should be deemed a hazardous waste for purposes of its disposal is currently under review by EPA.

7. Underground Tanks. Whether a tank is subject to the various elements of the RCRA program (which include notification, monitoring, and performance requirements) depends on its location and contents. A tank is deemed "underground" if its volume (including the volume of any connected underground pipes) is 10% or more "beneath the surface of the ground."24/ An underground tank is subject to regulation if it contains a "regulated substance." That term includes "hazardous substances" as defined in the federal Superfund law (*e.g.*, hazardous wastes listed under RCRA and hazardous chemical products) and petroleum (including crude oil that is liquid at standard temperature and pressure conditions).25/ Owners of underground storage tanks, including those "taken out of operation" after January 1, 1974, were required to notify designated state agencies of such tanks on or before May 8, 1986.26/

a. Design Requirements. EPA's proposed underground tank design requirements will be very costly to implement. Furthermore, a tank owner who complies with those requirements (or more rigorous state standards) and obtains a permit to operate the tank will not be protected from liability for cleanup costs if the tank leaks and causes contamination. As a consequence, a trend has developed toward removal of existing underground tanks, often as a prerequisite to closing a property sale. The tank removal process must be conducted in accordance with applicable state and local law and also can be very costly. The applicable laws are likely to require that the soil around and under the tank be sampled and analyzed for possible contamination, since leakage of old underground tanks is not uncommon.

b. Cleanup Requirements. To guard against contamination resulting from leaking tanks, RCRA requires EPA to establish regulations which impose release detection, prevention and correction requirements upon underground tank owners and operators. These regulations must require financial responsibility demonstrations by the owner or operator. As to underground petroleum tanks at petroleum production or refining facilities, the statute sets the minimum coverage per occurrence at $1 million. RCRA also includes a special program for cleanup of petroleum releases from underground storage tanks and a five-year, $500 million trust fund applicable to federal cleanup of tank releases in specified circumstances. Under that program, prior to EPA's adoption of tank regulations, EPA or a state authorized by EPA may compel tank owners or operators to clean up tank releases or itself undertake cleanup, as necessary to protect human health and the environment.27/

### 8. Nonhazardous Solid Waste Disposal

a. State Solid Waste Management Plans. In the area of nonhazardous waste disposal, as noted above, the states rather than EPA have primary authority to implement RCRA's requirements. Essentially, RCRA calls for state development of "solid waste management plans," which must include programs for issuing permits to solid waste disposal facilities. The principal purpose of these plans is to ensure that municipal and private landfills which receive primarily nonhazardous waste are built and operated in accordance with EPA standards. A further objective is to evaluate alternative waste disposal methods that will maximize resource conservation and recovery.28/

The Act provides two incentives for states to adopt plans that comply with EPA standards. First, such states are eligible for federal grants to assist in developing their solid waste management plans.29/ Second, if a state or locality operates a landfill that does not meet EPA's standards (a prohibited "open dump"), that entity is subject to enforcement action by EPA or private citizens (which could lead to imposition of penalties).30/

## B. Enforcement of RCRA's Hazardous Waste Management Requirements

Violation of a RCRA requirement may trigger enforcement action by the federal government, a state empowered to issue RCRA permits, or a private citizen.31/ Any "person" who violates the Act is subject to liability; "person" includes an individual, trust, firm, joint stock company, private or government corporation, partnership, association, state or state subdivision (such as a county), commission or interstate body.32/

1. Standard of Liability for Administrative Orders and Civil Actions. RCRA violations generally are governed by a strict liability standard where enforcement does not take the form of a criminal prosecution.33/ The sole prerequisite for issuance by EPA of an administrative compliance order (other than certain notice requirements, as indicated below) is a finding that a "person" has violated or is violating any of RCRA's hazardous waste management requirements; the same standard applies where

the government or a private citizen sues for injunctive relief and/or civil penalties.34/ Similarly, the standard for issuance of an administrative order requiring corrective action at an RCRA interim status facility is simply a finding that hazardous waste has been released from the facility into the environment.35/ A third type of order may be issued whenever EPA finds that waste management practices present "imminent and substantial endangerment to health or the environment"; again, the applicable standard is whether a person's actions have contributed to the emergency, not whether the person has acted negligently.

The strict liability standard sharply curtails potential defenses available to alleged violators who are the target of administrative or civil enforcement. Thus, for example, defendants who allegedly failed to respond to EPA requests for information about their hazardous waste activities could not contest liability.

2. Standard of Liability for Criminal Prosecutions. To be criminally liable under RCRA, the defendant must "knowingly" violate the Act. The elements which the government must prove to establish liability for various crimes are outlined below:

a. Knowing transport of hazardous waste to a facility without a permit to receive such waste.

b. Knowing treatment, storage or disposal of hazardous waste without a permit or in knowing violation of a permit condition or interim status requirement.

c. Knowing omission of "material" data from or falsification of required records, manifests, or other documents.

d. Knowing destruction, alteration, or concealment of, or failure to file, any manifest or other document required under RCRA by one who knowingly handles hazardous waste or used oil.

e. Knowing transport of hazardous waste without the required manifest.

f. Knowing export of hazardous waste without consent of the receiving country or in violation of an applicable export agreement.

RCRA also makes "knowing endangerment" a crime. This offense entails committing any of the above-listed acts with the knowledge that such act places another person "in imminent danger of death or serious bodily injury."36/ "Knowing endangerment" is subject to all general defenses, affirmative defenses, and bars to prosecution that may be raised with regard to other federal crimes.37/

3. Enforcement Procedures and Penalties. RCRA enforcement begins with the inspection powers which enable the government and the public to gain access to evidence of violations. RCRA empowers EPA and authorized states to inspect hazardous waste management facilities (TSDFs), operational or closed.38/ Indeed, the Act mandates annual EPA inspection of federal and state-run TSDFs and biannual inspection, by EPA or authorized states, of private TSDFs.39/

RCRA's broad inspection authority includes the power to enter and inspect "at reasonable times," to copy records pertaining to wastes managed at the facility, and to obtain waste samples.40/ Records and information obtained through a RCRA inspection are available to the public, unless entitled to trade secret protection under federal law.41/

The Act mandates "any person who generates, stores, treats, transports, disposes of, or otherwise handles or has handled hazardous wastes" to provide, upon a request by EPA or an authorized state, information about the wastes and access to records concerning them. Thus, a government request for information cannot be taken lightly. A refusal to comply constitutes a violation of the Act and subjects the violator to liability for penalties of up to $5000 per day and other relief available under the Act.

Penalties available for RCRA violations vary depending on whether the penalty is imposed by EPA (through an administrative order) or by a court (in a civil action or criminal prosecution). In general, the maximum penalty which EPA or a court may impose for a violation of a hazardous waste management requirement is $25,000 for each day of the violation; the same maximum penalty applies for each day that a TSDF fails to comply with a "corrective action" (cleanup) order or underground tank order issued by EPA. The maximum penalty for violating an EPA order compelling monitoring and testing activity is $5,000. In the criminal context, the maximum penalties (for first offenses other than "knowing endangerment") are a fine of $50,000 per day of violation and/or imprisonment for up to two years (five for crimes involving hazardous waste transport or TSDF permits). For a subsequent conviction, the maximums escalate to $250,000 and/or fifteen years' imprisonment (for individuals) and $1 million (for organizations).42/ For "knowing endangerment," the maximum penalties upon first conviction are $250,000 and/or fifteen years' imprisonment (for individuals) and $1 million (for organizations).43/

In addition to government enforcement, RCRA also allows private citizens to sue to enforce the hazardous waste management requirements, to prevent or correct an emergency condition caused by a hazardous waste release, or to challenge EPA action to implement RCRA.44/ Citizen suits against a private party are allowed only if the government fails to take enforcement action in response to the alleged violation or emergency. If a citizen prevails in an enforcement suit, or in attacking an EPA regulation or permit, the court may award costs (including attorney fees).

## C. Basic Elements of CERCLA's Cleanup Program

With CERCLA's enactment in 1980, Congress established a program to provide for cleanup of abandoned hazardous waste dumps and other sites contaminated by releases of hazardous substances. The primary elements of that program are a procedure to identify contaminated sites and two mechanisms to finance the cleanups. One mechanism involves the establishment of a tax-supported trust fund (known as the "Superfund" or the "Fund") to pay for cleanups planned and conducted by EPA.45/ EPA may then sue parties who are liable for the cleanup ("potentially responsible parties" or "PRPs") to recover its costs and reimburse the Fund.46/ The other mechanism is an enforcement procedure which enables EPA to compel PRPs to undertake cleanups.47/ PRPs and non-liable private parties who finance cleanups may seek to recover their costs from other liable parties or from the Fund.48/ CERCLA defines in very broad terms the parties liable for the costs of cleaning up a contaminated site, and those costs are likely to be astronomical.

The 1986 amendments to CERCLA provide for a five-year extension of the original CERCLA program and increase the Fund to $8.5 billion. The amendments also add considerable specificity to CERCLA's response process, in the form of rigorous cleanup standards, mandatory schedules for EPA review of potential Superfund sites, a requirement that EPA maintain an administrative record as to its cleanup decisions, and an emphasis on increased state and public involvement in the remedy selection and enforcement processes. Another important feature of the amendments is the incorporation of new procedures and options designed to facilitate settlement of cost recovery actions (and hence voluntary cleanups by PRPs). The major elements of CERCLA's cleanup program -- identification of problem sites, response cost liability, response authority and selection, cost recovery, and enforcement -- are sketched below, as reshaped by the 1986 amendments.

1. Identification of Contaminated Sites Under CERCLA. CERCLA comes into play when a site is identified as sufficiently contaminated with "hazardous substances" to warrant EPA

involvement in the cleanup process. This identification may occur in two ways: through a formal review and listing process by EPA or through notification to EPA of a release or threatened release at a site. In both cases, a site's contaminated status becomes a matter of public record.

First, CERCLA empowers EPA to investigate sites for potential contamination and create a list of those which are eligible for Superfund-financed cleanups (the National Priorities List or "NPL").49/ EPA places sites on the NPL based primarily on (1) each state's designation of sites that warrant top priority for cleanup and (2) a site's potential to harm human health or the environment, evaluated in accordance with the factors in EPA's detailed "Hazard Ranking System."50/

Second, CERCLA requires any person in charge of a structure or site from which a hazardous substance is "released" (spilled, deposited, leaked, or discharged in any manner) to notify the government, if the amount of the release is at a "reportable" level.51/ The determination of whether a release triggers this reporting requirement must be made on a case-by-case basis. Consultation with experts (*i.e.*, persons familiar with the relevant legal and technical issues) often is necessary to ensure an accurate determination.52/

CERCLA defines "hazardous substance" to include, *e.g.*, hazardous waste, toxic pollutants and hazardous substances listed under other federal laws (oil and petroleum are excluded unless they contain a hazardous substance).53/ Based on that definition, EPA has promulgated its list of the hazardous substances subject to CERCLA's requirements and the "reportable quantity" for each.54/ These quantities range from 1 to 5000 pounds; smaller quantities, however, may trigger notification requirements under state Superfund laws or other state laws pertaining to hazardous waste or substances.

2. Cleanup Cost Liability. CERCLA provides various means by which parties deemed "liable" for site cleanup costs and damages for harm to natural resources may be compelled to pay such costs and damages. Thus, before analyzing the statutory cleanup procedure and funding mechanisms, it is essential to review CERCLA's categories of potentially responsible parties ("PRPs"). Those parties are subject to strict liability, imposed on a joint and several basis (*i.e.*, each party may be individually liable for the *entire* cleanup cost). Liability is "strict" because it is imposed based on a defendant's *status* rather than any negligent *conduct* (act or omission) by such defendant; the law provides only a few narrow defenses. Furthermore, liability applies retroactively (to releases which occurred prior to CERCLA's enactment and to cleanup costs incurred prior to enactment) and is ongoing (if a generator sends hazardous waste

to a fully authorized disposal facility, for example, the generator remains liable for cleanup costs if the disposal facility leaks).

The first critical term in identifying PRPs is "person", since CERCLA's liability provisions refer to "persons" who are responsible for cleanup costs. A "person" under CERCLA means an "individual, firm, corporation, association, partnership, consortium, joint venture, commercial entity, United States Government, State, municipality, commission, political subdivision of a state, or any interstate body."55/

Second, CERCLA establishes four broad categories of "persons" who may be liable for cleanup costs and damages to natural resources caused by a release:

1. current site owners and operators of the contaminated site (regardless of whether their activities contributed to the contamination);

2. those who owned or operated the contaminated site at the time that hazardous substances were deposited there (*e.g.*, spilled or disposed of);

3. those who owned or possessed the substances and arranged for their treatment or disposal at the contaminated site or transport to that site; and

4. those who accepted the substance for transport to the contaminated site and selected that site.56/

Persons in the first two groups are generally called "owners and operators."57/ Those in the third group are known as "generators," and those in the fourth group are known as "transporters." The shorthand label which covers persons in all these categories is "potentially responsible parties" or "PRPs."

Each person who is a PRP as to a release from a facility or vessel is liable, by virtue of that status, for any or all of the following costs and damages arising from such release:

1. all cleanup costs incurred by the federal or state government (or an Indian tribe) which are "not inconsistent with" the NCP;

2. any other "necessary" cleanup costs incurred by a private party which are "consistent with" the NCP;

3. damages for injury to or loss of natural resources (including the costs of assessing such injury or loss); and

4. the costs of any health assessment or health effects study conducted by the federal Agency for Toxic Substances and Disease Registry.58/

The statute limits liability as to natural resources damages to $50 million, but that limit does not apply if:

1. the release resulted from willful misconduct or negligence within the PRP's privity or knowledge, or

2. the "primary cause" of the release was a violation, within the PRP's privity or knowledge, of an applicable safety, construction or operating standard; or

3. the PRP fails or refuses to cooperate fully with officials implementing the NCP.59/

Furthermore, a PRP who fails, "without sufficient cause," to undertake response action pursuant to an EPA order is liable for punitive damages of up to three times the amount of costs incurred by the Fund as a result of such failure.60/

The statute prescribes only four narrow defenses available to PRPs. A PRP may escape cleanup costs by demonstrating that the contamination was caused solely by an "act of God" or an "act of war," by qualifying for the "intervening third party" defense, or qualifying for the "innocent landowner" defense (a variation on the "third party" theme).61/

3. Response Authority. CERCLA specifies the circumstances under which EPA and PRPs are authorized to conduct cleanups, prescribes standards and procedures for selection of appropriate cleanup plans, and provides a variety of mechanisms for payment of cleanup costs. Three alternative avenues to cleanup financing and subsequent cost recovery are established:

1. Fund-financed cleanup by EPA or a state (pursuant to a contract with EPA). EPA or the state may sue PRPs to recover cleanup costs; EPA also may impose a lien on the subject property.

2. Cleanup financed by private parties and/or government entities named in an "imminent hazard" order issued by EPA or a court. Parties who comply with the order may be able to seek Fund reimbursement, cost recovery, and/or contribution.

3. Cleanup voluntarily financed by a state or local entity, PRP, or other private party. Those who undertake the cleanup may be able to seek Fund reimbursement, cost recovery, and/or contribution.62/

CERCLA affords EPA the discretion to decide whether it should pursue a Fund-financed cleanup and seek to recover its costs from PRPs or should order PRPs to undertake and/or pay for cleanup in the first instance.63/ CERCLA does not preclude PRPs and non-liable governmental or private parties from undertaking independent cleanups (where EPA has not already intervened), but provides strong incentives for such parties to coordinate with EPA or at the very least to frame their plans in accordance with CERCLA's prescribed standards. Summarized below are the provisions that define EPA's response authority, the standards to be applied in response planning, and the means by which cleanup costs may be imposed on PRPs.

a. Basic Scope of EPA's Response Authority ("Removal" and "Remedial" Actions). EPA is empowered to investigate and respond to a release or threatened release of a hazardous substance or of any "pollutant or contaminant" which may endanger the public. Responses fall into two categories: "removal" and "remedial" actions (a removal may be one component of a remedial action). A "removal" action, generally, is a short-term response entailing removal and or disposal of contaminated materials.64/ A "remedial" response constitutes actions designed to facilitate a permanent remedy (rather than temporary, stop-gap emergency measures). A remedial action may include confinement of the contaminated area (e.g., through diking and/or covering the site); neutralization, incineration, or other treatment of contaminated materials; removal through dredging or excavation; off-site storage, treatment, destruction, and/or "secure disposition" of removed materials; monitoring to ensure continued protection to the public; and permanent relocation of residents, businesses, and community facilities (if necessary to protect public health or more cost-effective than off-site management of removed materials). A remedial action taken or authorized by EPA must be preceded by a remedial investigation and/or feasibility study ("RI/FS") to evaluate the threat posed by the release and consider alternative remedies.65/

In order for EPA to undertake a remedial action with Fund financing, EPA must obtain prior contractual state assurances of support in specified areas: (a) ongoing measures to maintain the effectiveness of the response for its "expected life"; (b) availability of a hazardous waste disposal facility in compliance with RCRA and acceptable to EPA; and (c) state payment of 10% of the remedial action costs (including future maintenance) or, if the state operated the facility to be cleaned up at any time when hazardous substances were disposed there, 50% of any response costs. EPA may enforce these cost-sharing agreements in federal court. Cost-sharing agreements also are required when EPA authorizes a state to independently undertake a Fund-financed removal or remedial action.66/

b. Access, Inspection, and Condemnation Authority. The 1986 amendments substantially expand the powers of EPA and states acting pursuant to agreements with EPA to enter sites, conduct inspections, take samples, and obtain relevant information.67/ The amendments further explicitly authorize EPA to exercise eminent domain powers over any real property which EPA determines is "needed" in order to conduct a remedial action. These provisions afford EPA the means to exert significant control over any property which is a potential response target and neighboring properties as well.

EPA may enter sites, inspect, and collect data in order to assess the need for, plan, or implement a cleanup response. The entry and inspection powers may be exercised if EPA has a "reasonable basis" to believe that a release may be present or threatened at the site in question. The data-gathering power may be exercised so long as EPA provides "reasonable notice" to the person who has or may have the desired data. Upon such notice, EPA must be furnished with information and documents concerning the following: any substances generated, treated, stored, or disposed of at a vessel or facility; releases or threatened releases of a hazardous substance, pollutant, or contaminant at or from a vessel or facility; and a person's ability to pay for or perform a cleanup.68/ Thus, if EPA has adequate evidence that a PRP may be a source of contamination, EPA may readily obtain data concerning a PRP's financial status and the scope of its insurance coverage.

EPA also may acquire, by "purchase, lease, condemnation, or otherwise," any land or interest therein, if EPA determines prior to or during a remedial action that such property is needed to conduct the remedial action.69/ Thus, if EPA obtains access to a site to implement a remedial action, and determines that implementation will result in a taking of private property, EPA is authorized to acquire that property by condemnation or other means and may finance such acquisition through the Fund.70/

c. Delegation of EPA's Cleanup Authority to the States. If a state or Indian tribe seeks to clean up an NPL site or take any other action which EPA would be empowered to take (including site entry and inspection, land acquisition, and enforcement), the state may apply to EPA for an agreement authorizing the state to carry out such actions. Such an agreement must impose the cost-sharing obligations outlined above.71/

4. Response Selection: RI/FS Preparation and Prescribed Cleanup Standards. In exercising its response authority, EPA must adhere to the response planning provisions added by the 1986 amendments, which mandate (among other requirements) public involvement in the planning process, preparation of an administrative record, the use of prescribed response selection criteria, and expansion of the National Priority List of contaminated sites by specified deadlines.72/ CERCLA also requires that EPA revise its regulatory cleanup procedure, the National Contingency Plan ("NCP"), to accord with the new standards.73/ The NCP and the statutory standards are the yardsticks against which cleanup plans are measured to determine whether they qualify for Fund financing or adequately fulfill PRP cleanup obligations.

The principal elements of CERCLA's response selection processes entail (1) a preliminary assessment to determine whether a removal response is necessary; (2) a site characterization and evaluation of alternative remedial actions (the remedial investigation and feasibility study, or "RI/FS"); and (3) the selection of a cost-effective remedy that mitigates the threat posed by the release and adequately protects public health and the environment.74/ The 1986 amendments afford substantial opportunities for public participation in this process.75/

Once the RI/FS process is completed, EPA (or a state responsible for remedy selection pursuant to an agreement with EPA) must provide notice of the proposed remedy, an opportunity to submit written and oral comments, and an opportunity for a public meeting at or near the site; a transcript of the meeting must be kept and made available to the public. When a final cleanup plan has been adopted, notice of that plan must be published (with an explanation of changes in the proposed plan and a response to "significant" comments) and the plan must be made available to the public before cleanup action is commenced. Furthermore, if the action as carried out differs in any significant way from the final plan, EPA or the state must publish an explanation of such differences. As an additional incentive to maximize participation by members of the public who may be affected by a release or threatened release, federal grants (of up to $50,000 per recipient) may be awarded to obtain technical assistance in interpreting data concerning a proposed remedial or removal action.76/ Finally, the amendments authorize private citizens to enforce CERCLA's requirements, including the new standards for adequate removal or remedial actions, through lawsuits for injunctive relief and civil penalties.77/

a. Preference for On-Site Treatment. A central feature of the new standards is the strong preference for on-site treatment of released hazardous substances rather than off-site disposal of contaminated materials. Where "practicable" treatment technologies are available, offsite transport and disposal of untreated hazardous substances or contaminated material is the least favored alternative remedial action. Selected actions must protect human health and the environment, be cost-effective, and utilize alternative treatment or resource recovery technologies "to the maximum extent practicable."78/ EPA must include, in the revised NCP, standards and procedures for determining whether particular alternative or innovative technologies are "appropriate" for use in response actions.79/

If a remedial action includes not only on-site treatment but also removal of hazardous substances for off-site treatment, storage, or disposal, the substances may be transferred only to a facility which is operating in compliance with RCRA's requirements and other applicable federal and state requirements. The substances may not be land disposed unless EPA determines that they will be placed in a unit that is free of leaks and that any releases from other units of the disposal facility are controlled by an approved RCRA corrective action program.80/

b. Legally Applicable or Relevant and Appropriate Requirements ("ARARs"). A treatment plan selected for a particular site must be designed to ensure that the cleanup is extensive enough to assure protection of human health and the environment. To achieve that objective, any hazardous substance or pollutant that remains onsite must be treated to attain all standards which are "legally applicable" to the substance or "relevant and appropriate" for purposes of the release. The "applicable" standards are those prescribed pursuant to federal environmental law or any more stringent standards adopted under state environmental or siting laws. The amendments specify, however, that onsite remedial actions approved by EPA and conducted in accordance with the applicable standards may be undertaken *without* obtaining federal, state, or local permits.81/

c. Limited Impact of Cost-Effectiveness Requirement. The amendments specify that selected remedial actions are to provide for a "cost-effective" response. EPA's cost-effectiveness review of remedial alternatives must address both short-term and long-term costs, including those of operation and maintenance for the duration of remedial activities.82/ That analysis cannot be made, however, until the desired level of cleanup (*i.e.*, the applicable or relevant criteria which must be satisfied as to each hazardous substance) has been determined. As a general matter, it is anticipated that use of the new statutory standards will result in escalated remedial action costs. Of particular importance, therefore, is the new provision which allows for waivers from the rigorous and expensive standards under certain specified circumstances.

d. Waiver Prerequisites. The amendments also allow EPA to adopt a remedy which assures protection of health and the environment, but does not attain the applicable federal or state criteria, if one of six requirements is satisfied. These waiver requirements are as follows:

1. the selected remedy is only part of a total remedy which ultimately will attain the applicable criteria;
2. compliance with the applicable criteria will create a greater risk to health and the environment than the selected remedy;
3. compliance with applicable criteria is technically impracticable;
4. the selected remedy attains a performance standard equivalent to the applicable criteria;
5. the applicable state criteria have not been consistently applied by the state; and
6. as to Fund-financed actions undertaken by EPA or a state pursuant to CERCLA [fn], the selected remedy reflects a balance between the need for environmental protection at the site and the need to ensure Fund availability for cleanup elsewhere.83/

The first five waiver options appear sufficiently broad and flexible to be invoked by PRPs in a wide variety of circumstances. The statute says little about the procedure for seeking a waiver, except to require that EPA publish its waiver findings with an explanation and appropriate documentation. Presumably, the revised NCP will incorporate such a procedure.

e. Statutory Cleanup Schedules. The new cleanup standards are complemented by mandatory schedules which require EPA to expand and accelerate its evaluation of potentially contaminated sites and its cleanup operations. By 1988, EPA must review some 23,000 sites already identified as possibly contaminated to determine which ones should be inspected. By 1990, EPA must determine which of these sites belong on the NPL. In addition, EPA must push to begin cleanup activity at 375 NPL sites by October 17, 1991.84/ These statutory deadlines may intensify federal scrutiny of old industrial and manufacturing facilities.

### 5. Statutory Mechanisms for Funding Cleanups

a. EPA Orders Compelling PRP Cleanups. As an alternative to conducting a Fund-financed response and suing PRPs to recover its costs, EPA is authorized to issue an administrative order compelling PRPs to carry out an EPA-approved cleanup or to seek injunctive relief. That authority is triggered when a release or threatened release of hazardous substances poses an "imminent and substantial endangerment" of harm to the public health or welfare or the environment.85/

Claims asserted in an EPA cleanup order may be resolved through a settlement negotiation, enabling PRPs to work out with EPA the terms and conditions under which they will fund and participate in the cleanup. PRPs who do not join in the settlement remain liable to settling PRPs for contribution and to EPA for any costs not covered by the settlement.86/

b. Cost Recovery Actions, Natural Resources Damages, and Federal Liens. CERCLA, as noted above, allows government entities or private parties who fund response actions to sue PRPs to recover their costs. As indicated above, PRPs are liable for response costs, damages for harm to natural resources, health assessment costs, and accrued interest, unless one of the statute's few defenses or liability limitations applies. In addition, EPA is empowered to record a lien for its response costs and damages for harm to natural resources against the subject property. The ambiguous language in CERCLA's provisions for cost recovery and natural resources damages actions has spawned more litigation than actual cleanups.

A government entity -- federal, state, or local -- or an Indian tribe, which has "incurred" removal or remedial actions costs (whether Fund-financed or not), may sue any PRP for all such costs "not inconsistent with the national contingency plan." In addition, any other person (*i.e.*, anyone within CERCLA's definition of "person" other than a government entity or Indian tribe) who has incurred "other necessary" response costs "consistent with the national contingency plan" may sue to recover such costs.87/ The numerous cost recovery issues which have been subjected to judicial scrutiny include the stage at which costs may be deemed "incurred" and the scope of recoverable costs.

A lawsuit against PRPs to recover damages for injury to, destruction of, or loss of natural resources may be brought by designated federal or state officials acting as trustees of such resources on behalf of the public. No action may be brought, however, when the alleged damages and the release which caused them arose "wholly" before December 11, 1980. Damages recovered by the federal government or a state must be used to restore or replace the injured resources or acquire their equivalent. The measure of damages is not restricted to sums necessary to restore or replace the resources.88/

Under the 1986 amendments, all costs and natural resources damages for which a PRP is liable to EPA constitute a lien upon all real property and interests therein which are owned by the PRP and are subject to or affected by a response. The lien arises at the later of the time when EPA first incurs response costs or when the PRP is provided with notice of potential liability (by certified or registered mail). It lasts until the PRP's liability (or a judgment reflecting that liability) is satisfied, or the statute of limitations for enforcing such liability expires without the filing of a suit.89/

6. Settlement of EPA Claims Against PRPs. If EPA chooses to exercise its response authority at a particular site, EPA may involve PRPs through discretionary settlement negotiations, triggered by pending cleanup orders, threatened cost recovery claims, or RI/FS preparation. CERCLA does not prohibit PRPs from independently initiating action to clean up a release of hazardous substances, assuming that EPA has not commenced the response process or indicated an intent to take the lead in that process. Before enactment of the 1986 amendments, EPA undertook negotiations pursuant to its established settlement policy; the amendments provide a statutory framework for negotiations that accords in several respects with EPA's policy.

Important features of this discretionary settlement process include advance notice to PRPs who can be identified; preliminary allocation of cleanup responsibility among PRPs; expedited settlement with "de minimis" PRPs; partial Fund financing of response actions; qualified covenants not to sue; discharged liability for contribution; and opportunities for public comment on proposed settlements. Three particularly significant features, those pertaining to de minimis PRPs, covenants not to sue, and relief from contribution liability, are summarized below.

a. De Minimis Settlement Procedure. The de minimis procedure was added to address the inequities which CERCLA's joint and several liability standard created for PRPs who contributed relatively small volumes of hazardous waste to a contaminated site. That provision authorizes EPA to settle "as promptly as possible" with PRPs where the following requirements are met:

1. Settlement with the PRP would cover only a "minor portion" of the total response costs; and either

2. The PRP's contribution to the contamination is "minimal" compared to that of others, in terms of both the amount and the hazardous effects of the substances contributed; or

3. The PRP meets all the requirements for the "innocent landowner" defense except that the PRP failed to make the due diligence pre-purchase investigation necessary to establish that defense.90/

A de minimis settlement is available only at EPA's discretion, and EPA's decision on whether to pursue that option may not be appealed to a court. Such a settlement may include a covenant not to sue, again at EPA's discretion. The final agreement must be formalized as a consent decree or embodied in an administrative order. The settlement frees the de minimis PRP from potential contribution liability.91/

b. Covenants Not to Sue. The future liability of settling PRPs may be limited in accordance with a covenant not to sue. EPA determines the scope of the covenant (full or partial release from future liability), based in part on the permanency of the selected remedial action. EPA may provide a covenant at its discretion if it finds that: the covenant is in the public interest and would expedite cleanup; the PRP is in compliance with a consent decree setting forth its response obligations; and EPA has approved the response. A covenant is mandatory rather than discretionary if:

1. the requirements for a discretionary covenant are met, and EPA has required a response involving offsite disposition of a hazardous substance, after rejecting a proposed response that did not call for such disposition; or

2. the requirements for a discretionary covenant are met, and the response involves treatment so that the hazardous substances and their by-products are permanently destroyed.

No covenant to sue takes effect until EPA certifies that the remedial action that is the subject of the settlement has been properly completed.92/

All covenants, except the mandatory covenants and those included in settlements with de minimis PRPs, must include reopeners. The reopeners allow EPA to sue settling PRPs for future response costs, where such costs arise from conditions that are "unknown" at the time EPA certifies that the original remedial action has been completed. EPA has discretion to omit the reopener, but only in "extraordinary" cases and only if other terms of the settlement adequately protect the public and the environment from future releases.93/ The required reopeners may diminish the value of covenants not to sue as a settlement inducement for PRPs.

If EPA enters into a settlement agreement which includes a covenant not to sue, that covenant protects the settling PRPs, but those not a party to the suit remain subject to enforcement action. If the agreement covers some but not all of the recoverable costs, both settling and non-settling PRPs remain liable for the costs not included.94/

c. Relief from Contribution Liability. A cost recovery settlement with EPA relieves the settling PRP(s) from liability for contribution as to the response covered by the settlement, and reduces the potential liability of non-settling PRPs by the amount of the settlement. Non-settlors, of course, remain liable to settling PRPs for contribution and to EPA for recovery of costs not covered by the settlement.95/

## D. CERCLA Enforcement

CERCLA's cleanup requirements may be enforced through three avenues. First, civil penalties and injunctive relief may be sought (through citizens suits or suits brought by the government) against parties, including EPA, who fail to meet their CERCLA obligations.96/ Second, EPA may assess administrative penalties, through formal or informal procedures, for specified violations by private parties or other federal agencies.97/ Third, some violations are punishable as crimes.98/ CERCLA's enforcement mechanisms are outlined below.

1. Judicial Authority: Civil Penalties and Injunctive Relief. A federal district court may impose civil penalties, in lawsuits by EPA or private citizens, for violations of:

1. The release reporting requirement;
2. The prohibition against destruction or falsification of records;
3. The requirements concerning inspection and data-gathering or orders enforcing those requirements;
4. The financial responsibility requirements; or

5. Administrative orders, agreements, or consent decrees reflecting settlements of cleanup claims.99/

Violations pertaining to government requests for data or consent to enter and inspect may be punished by a maximum penalty of $25,000 for each day of noncompliance.100/ With regard to other violations, the maximum penalty for a first violation is $25,000 for each day of the violation. For subsequent violations, the maximum penalty increases to $75,000 per day.101/

Injunctive relief is available against private parties or federal agencies to correct violations of CERCLA requirements, to clean up sites posing an "imminent hazard" to health or the environment, and to enforce settlement or penalty orders.102/ In addition, a private citizen may sue in federal court to compel EPA or any federal official subject to a CERCLA mandate to perform the mandated act or duty.103/

2. EPA's Enforcement Authority: Compliance Orders and Administrative Penalties. EPA may issue orders to: compel compliance with data-gathering or inspection requests; compel cleanup of sites which pose an "imminent hazard;" formalize the terms of cleanup settlements; and impose administrative penalties.104/ Such orders are enforceable through civil actions for penalties and/or injunctive relief, as explained above.

As an alternative to seeking judicial enforcement, EPA may assess penalties for violations of most CERCLA requirements and settlement orders. If EPA follows an informal penalty assessment procedure, it may assess a maximum penalty of $25,000 per violation (a "Class I" penalty). If EPA follows a more formal procedure, the maximum penalty for a first violation is $25,000 for each day of the violation, increasing to $75,000 per day for subsequent violations ("Class II" penalties).105/

3. Criminal Penalties. Criminal penalties are available for knowing violations of certain CERCLA requirements and intentional violations of EPA orders to clean up "imminent hazard" sites. These penalties include substantial fines (*e.g.*, $25,000 for each day of violation of an "imminent hazard" order) and lengthy prison sentences (up to 5 years for some violations). As an incentive to report criminal violators, CERCLA provides for a reward of up to $10,000 (paid for by the Fund) for information leading to the violator's arrest and conviction.106/

4. Citizen Suits. CERCLA authorizes private citizens to sue CERCLA violators for civil penalties or injunctive relief; citizens also may sue EPA to compel performance of duties mandated by the Act. This authority is broad enough to encompass suits contending that a cleanup action by a private or

governmental defendant failed to meet applicable standards. A citizen may not file suit, however, until 60 days after notice of the suit to EPA, the state in which the alleged violation occurred, and the violator. No suit may be filed if EPA has already initiated and is prosecuting an action under CERCLA or RCRA concerning the requirement at issue.107/

## II. PROBLEMS IN RCRA AND SUPERFUND IMPLEMENTATION

After eleven years of experience with RCRA and seven years of experience with Superfund, a number of critical defects in the U.S. system for preventing and remedying hazardous waste contamination have emerged. Some of the recent amendments to RCRA and Superfund, intended to ameliorate these problems, may actually exacerbate them. The list below represents only a partial summary of relevant concerns, but may serve to illustrate the types of unforeseeable issues which can impede even the most carefully designed waste management and cleanup program.

### A. Insurance Crisis

Over the past few years, the availability of insurance to cover potential liability for clean-up costs and other damages pertaining to environmental pollution has dwindled to the point where it is all but non-existent. The immediate cause of this problem is the explosion of claims for cleanup costs and toxic torts stemming from the release of hazardous substances into the environment. It has been estimated that individual major insurers are each currently attempting to deal with well over 1,000 pending environmental claims. With regard to cleanup costs, the plethora of claims reflects two underlying causes: (1) the statutory standard of strict, joint and several liability and (2) the judicial interpretation of the so-called "pollution exclusion clause" found in comprehensive general liability ("CGL") policies from the late 1960s until 1985. These circumstances, taken together, have basically transformed many insurance companies into the primary sources of reimbursement for cleanup costs paid out by the Superfund or by private parties. As a consequence, insurers have greatly expanded the scope of the pollution exclusion in their CGL policies. Furthermore, although separate policies designed expressly to cover environmental claims were available for a few years (environmental impairment liability or "EIL" policies), insurers now generally refuse to issue such policies.

In a sense, this crisis is an inevitable result of the conflicting policies embodied in the insurance laws, on the one hand, and the environmental laws, on the other. The concept of insurance is grounded in the theory that it makes sense to distribute liability risks among numerous businesses that are potentially subject to such liability. Laws such as RCRA and

CERCLA, however, reflect the assumption that risk-spreading does not further environmental protection, and hence authorize the government to compel any one "liable" party to finance an entire site cleanup -- even if the sole basis for "liability" is site ownership.

1. Impact of the Strict, Joint and Several Liability Standard. Under a scheme in which liability is imposed without regard to fault, an insurer gains little comfort from data which ordinarily might demonstrate that a policyholder represents a sound risk. Superfund cleanup liability may be imposed simply by virtue of a company's status as owner of the site on which contamination occurred, regardless of whether the owner's conduct in any way contributed to that contamination. (See Part I.) Therefore, the fact that an owner has a history of sound waste management and disposal practices and has consistently complied with applicable environmental laws has no bearing on whether the owner may sustain future liability for cleanup costs -- which could be passed on to the insurer.

Moreover, because Superfund liability is "joint and several", a single liable party such as the landowner may be compelled to pay 100% of the cleanup costs, even though numerous other parties may actually have contributed to the contamination. A party who funds a cleanup has a right to recover the costs from responsible parties on a pro rata basis. That option does not make the insurance risk any more attractive, however, since such recovery ordinarily can be accomplished only through protracted and expensive litigation (for which the insurer may have to foot the bill).108/

As a final nail in the coffin, Superfund liability is retroactive and ongoing. A company which disposed of hazardous wastes on-site long before enactment of RCRA or CERCLA, in full compliance with whatever laws applied at the time, remains liable for clean-up costs if the disposals are later deemed to have caused contamination at the site. Similarly, a company which sends waste for off-site disposal remains liable -- virtually forever -- for costs associated with subsequent releases at the disposal facility. Given the extraordinarily sweeping liability standard, in conjunction with the astronomical costs of cleaning up contamination (discussed in section 4, below), the reluctance of insurers to issue policies covering potential cleanup liabilities should not come as a surprise.

2. Impact of the Pollution Exclusion Clause. The "pollution exclusion clause", standard in CGL policies until 1985, usually reads as follows:

> This insurance does not apply: to bodily injury or property damage arising out of discharge, dispersal, release or escape of smoke, vapors, soot, fumes, acids, alkalis, toxic chemicals, liquid or gases, waste material or other irritants, contaminants or pollutants into or upon land, the atmosphere or any water course or body of water; but this exclusion does not apply, if such discharge, dispersal, release or escape is sudden and accidental. [Emphasis added.]

Thus, under the clause, CGL insurance would not cover damage arising from environmental pollution -- unless such pollution occurred in a "sudden and accidental" manner. The principal question which this language has posed for the courts is whether the "sudden and accidental" exception should be restricted to relatively brief, emergency situations (such as an accidental spill) or should be interpreted broadly to include gradual, ongoing releases of hazardous waste or substances (such as a slow landfill leak which eventually permeates a wide area of soil and migrates into the groundwater).

A number of courts have interpreted the "sudden and accidental" exception narrowly, and denied coverage when the insured had some measure of responsibility for or prior knowledge of the contamination (so that it was not "accidental") or when the release occurred gradually or over a long period of time (so that it was not "sudden").109/ Other courts, however, have taken a different view. Some of these courts have construed the clause as ambiguous, necessitating an interpretation in favor of the insured under established principles of contract interpretation. These courts have concluded that the "sudden and accidental" exception should apply whenever the contamination at issue was "unexpected" or "unintended" -- a view which requires insurance coverage of costs expended to clean up slowly migrating contamination and to compensate individuals harmed by exposure to such contamination.110/ One rationale advanced for this conclusion is that the pollution exclusion clause simply restates the "occurrence" definition found in CGL policies, which purports to cover conditions which are continuous in nature. That definition, arguably, would be inconsistent with the pollution exclusion clause unless the phrase "sudden and accidental" was held to include continuous releases leading to unexpected damage.

The cases holding that the "sudden and accidental" exception includes gradual releases have extended coverage not only to cleanup costs but also to toxic tort damages arising from an individual's exposure to such releases. Such coverage, moreover, extends to the liable party's defense costs as well as the judgment itself. Here again, it is scarcely surprising that the insurers deleted the "sudden and accidental" exception in 1986, modifying the pollution exclusion clause to specify that the exclusion covers both sudden and non-sudden events. At this point, although various arrangements have been proposed to substitute for conventional environmental liability coverage (see Part III), numerous potentially liable entities are operating with relatively little protection.

B. Flood of Litigation. Over the past fifteen years or so, the federal environmental laws, CERCLA and RCRA among them, have spawned some 3,000 judicial decisions. That figure does not include the even larger number of administrative decisions addressing disputes arising under these statutes. There are a number of causes for this explosion; a few of the major causes are outlined below.

1. Strict Liability Standard. The litigation explosion, like the insurance claim explosion, reflects in part the fact that CERCLA treats all potentially liable parties exactly the same, regardless of any party's actual degree of responsibility for contamination. Therefore, a company which believes it has minimal responsibility for contamination at a site, and compelled by the government to finance a substantial portion of the cleanup costs, is likely to turn to the courts in hopes of recovering some or all of those costs from other liable parties. A frequent scenario, for example, involves a lawsuit by a company which unknowingly purchased contaminated property and paid to clean it up against any prior owner(s) or operator(s) whose activities contributed to that contamination. Furthermore, once it becomes public that a site is seriously contaminated and that particular companies are believed responsible for the contamination, private individuals residing in the vicinity of the site may institute litigation claiming that those companies are responsible for reduced property values, injury, or illness resulting from exposure to the contamination.

2. Prior Lack of Established Response Selection Criteria ("How Clean is Clean"). As a supplemental problem, ambiguities in EPA's Superfund cleanup regulation, the National Contingency Plan ("NCP"), stimulated further litigation. The NCP, as originally framed, did not include specific cleanup standards. As a result, parties would litigate not only who was liable for cleanup costs but also the validity of the costs themselves. These disputes were a direct offshoot of the "how clean is clean" dilemma, which the 1986 Superfund amendments incorporating mandatory cleanup standards will not fully resolve. It appears likely that, as in the past, enormous sums will be devoted to selecting and debating remedial actions; that debate, in turn, may become the subject of further litigation. EPA, however, as discussed in Part III, is taking some steps to identify the controversies triggered by the new cleanup standards and defuse those controversies before they overwhelm the NCP revision process.

The costs of planning a cleanup escalate partly because planning is impeded by the scientific uncertainties in risk assessment, and controversies over acceptable remedies generate substantial delays. EPA's Superfund staff estimates an average of 6 months for initial project planning, followed by an average of 25 months to review and analyze potential alternative remedial actions. This process is termed the remedial investigation and feasibility study, or "RI/FS", and can entail the use of numerous outside technical consultants, with concomitant expenses for whatever hydrogeological analysis is deemed appropriate. EPA's staff apparently hopes to reduce project planning time to 3 months and RI/FS preparation time to 18 months, through efforts to initiate fieldwork earlier in the process, shorten times for EPA review of proposed remedies and other data, and eliminate duplicative activities.111/ One problem inherent in implementing these reforms, however, is that each of EPA's ten regional offices (located throughout the country) is likely to assume RI/FS responsibility as to cleanup sites in its area. Thus, the extent to which the RI/FS process can be expedited may be a function of resource allocation and priorities within each regional office.112/

3. Problems in Developing a Workable Settlement Procedure. Although EPA adopted a Superfund settlement policy in 1985 (which is reflected in CERCLA's new settlement provision), that policy has not been an effective tool in facilitating settlements and thus has not served to prevent litigation or expedite cleanups. A variety of problems have undermined the policy's usefulness, and codification of the policy in CERCLA is not likely to erase those problems overnight. They include the following:

1. the fact that use of the settlement procedure as an alternative to litigation is discretionary, not mandatory;

2. EPA's former practice of insisting that available parties agree to pay, not only their share of the costs, but also the shares of absent parties (CERCLA's new settlement provision allows but does not require EPA to use the Fund to pay shares owed by non-settling parties; EPA has issued the ambiguous statement that it will restrict this "mixed funding" approach to "the right cases");

3. EPA's delays in developing specific policy and procedural guidance germane to the response selection process and in providing potentially liable parties with data concerning the scope and nature of site contamination and their individual contributions to it (again, CERCLA's new settlement provision provides for

EPA release of such data, but past experience suggests that the date will be sparse and slow in coming);

4. the requirement of "reopeners" in covenants not to sue, which EPA interprets as extending not only to previously unknown site conditions but also to situations when the agreed-upon remedy appears no longer sufficiently protective of public health or the environment;

5. the likelihood that any major cleanup site will involve numerous liable parties, each with independent positions to assert on such issues as the appropriate degree of cleanup and the appropriate standards for cost allocation -- even if the parties appoint a committee to take the lead in negotiating with EPA, complex and time-consuming disagreements among the liable parties are inevitable;

6. uncertainty and disputes as to the respective roles that should be played by technical personnel (EPA technical staff, industry consultants) and attorneys in negotiating sessions;

7. the possibility that EPA will not involve potentially liable parties in the settlement process until after completion of the remedy selection process, thereby denying those parties a voice in that process and opening the door to attacks on the remedy that will further delay settlement (and hence cleanup); and

8. EPA's use of various computer models, of disputed reliability, to assess such financial issues as each party's "ability to pay" its share of cleanup costs, the projected amount of future cleanup costs, and the projected value of litigation.

These problems all increase in magnitude in direct proportion to the number of potentially liable parties ("PRPs") and the extent of contamination involved at any given site. Thus, the very sites that are most in need of speedy and effective cleanups, i.e., major sites experiencing significant migration of hazardous substances through soil and/or groundwater, are most likely to be the subject of protracted litigation and/or negotiations.113/ One issue that has been particularly difficult to resolve at large multiparty sites, as suggested above, is the question of whether EPA or the PRPs should take the initiative to move ahead with the RI/FS phase of the response. In the past, PRPs often have taken the position that they prefer to assume that responsibility, thereby (in theory) retaining some measure of control over costs expended for investigatory measures and assessment of proposed remedial alternatives. When PRPs take the lead, however, EPA or a state agency with response oversight powers may require studies and other investigatory efforts beyond those that the government, using Fund monies, would undertake. In effect, EPA expects the PRPs to write out a blank check to cover whatever RI/FS activities EPA deems appropriate. Thus, a more recent trend among PRPs is to leave the RI/FS process in EPA's hands, despite the inevitable uncertainty as to both costs and duration.

As a related concern, the various avenues for public involvement provided under the 1986 amendments may prolong the process of reaching agreement on a remedy and the ultimate costs for PRPs, EPA, and state participants may increase accordingly. In addition, the availability of technical data and expert assistance to the public may increase the likelihood of private suits against PRPs based on alleged personal injuries or property damage caused by facility releases.

Another factor which exacerbates the complexity of multiparty settlements is the likelihood that PRPs will break down into factions with vastly differing priorities. In particular, the question of how to deal equitably with parties whose contributions are very small -- "de minimis" contributors -- has been a major stumbling block. The CERCLA amendments, as noted above, allow EPA to make special settlement arrangements with such parties so that, by paying a specified amount at the outset of negotiations, they can "cash out" their liability and avoid the high transactional costs of involvement in prolonged negotiations and any associated litigation. Pursuant to the amendments, EPA has published its "interim" guidance concerning de minimis settlements. Unfortunately, the guidance is very general, and thus provides little hard assurance as to the standards that will determine whether and how de minimis parties can settle early. For example, EPA's guidance provides that to qualify for "de minimis" status a party must have contributed a "minimal" amount of waste to the site -- but EPA fails to define what is meant by "minimal." Similarly, EPA says that the wastes contributed by a de minimis party must not be "significantly more toxic" than those contributed by other parties -- again, however, no clear standards are offered for deciding whether one waste is "significantly" more toxic than others. As another concern, EPA has indicated that de minimis settlements ordinarily will not be available until after completion of the RI/FS stage and remedy selection. Thus, even if a de minimis party is able to settle before the actual cleanup goes forward, that party still will have to participate in the lengthy, contentious, and costly RI/FS process. Further, EPA is unwilling to provide unqualified releases from liability to de minimis parties, at least in the absence of up-front "premium" settlement payments.114/ Not surprisingly, in view of this amorphous guidance, de minimis settlements do not seem to be rapidly materializing.

4. Fund Inadequacy to Meet Escalating Cleanup Costs. Although the 1986 CERCLA amendments authorized a total of $8.5 billion for Superfund use over the next five years, that amount is a tiny fraction of the estimated sums needed to clean up sites already identified -- leaving aside those which are likely to materialize in future, as EPA speeds up its investigation and prioritization of target sites. It has been estimated that some 10,000 additional sites are likely candidates for EPA's National Priorities List; some 800 sites are presently listed.115/

The cost of remedying contamination at these sites, and repairing damage to natural resources caused by such contamination, is overwhelming. Before Superfund was amended to specify new and rigorous mandatory cleanup standards, the cost of cleaning up any one NPL site was generally estimated at about $9 million. (The legal costs of defending Superfund actions figure significantly in these estimates.) The advent of the new standards has boosted that estimate to between $30 million and $50 million per site - and if groundwater cleanup is needed, the estimate escalates to between $320 million and $600 million per site.116/

The $8.5 billion Fund obviously cannot meet this demand, and it is not intended to do so. CERCLA's enforcement mechanisms, described in Part I of this paper, are designed as hammers to stimulate liable parties to pay their share of cleanup costs, thereby reimbursing the Fund for whatever amounts EPA has withdrawn to remedy contamination. The higher cleanup costs become, however, the more the PRPs can be expected to resist EPA's payment demands -- with corresponding slowdowns in settlement negotiations and renewed emphasis on litigation.

The costs for both EPA and PRPs, of course, are not confined to actual expenditures for planning and executing a response action. As suggested in the foregoing discussion of settlement problems, astronomical transaction costs are likely to arise, in form of attorney fees, consultant and laboratory fees, litigation costs, and lost opportunity costs for PRPs when personnel and other resources must be shifted from revenue-producing activities to response action planning. A company enmeshed in EPA's response action process may be compelled to approve major expenditures based on very little hard data. The types of concerns that delay the industry decisionmaking process and tend to increase transaction costs include the following:

1. incomplete data as to hazardous constituent parameters and volume,

2. inadequate or nonexistent data on scope and direction of groundwater plume,

3. ambiguous criteria on acceptable cleanup levels, treatment techniques, and disposal options,
4. insurance availability undetermined,
5. opposition and mistrust from local citizens and politicians,
6. conflicting recommendations by government and industry technical experts,
7. lack of internal familiarity with the issues and attendant risks (costs and public image), and
8. lack of control over extent and nature of costs.

The high cost of cleanup stems in large part from the difficulties posed by these issues. No quick resolutions are currently available, although EPA's efforts to implement the 1986 CERCLA amendments through guidance and regulatory proposals may help to facilitate remedy planning and cost settlements (see Part III).

## C. Problems in Siting and Permitting Hazardous Waste Management Facilities

There can be no doubt that, despite encouraging developments with regard to waste minimization and new treatment technologies, the U.S. faces an ongoing crisis in its capability to safely treat and dispose of hazardous waste. EPA data indicate that some 275 million metric tons of hazardous waste (most consisting of dilute process wastewaters) were managed in the U.S. in 1985, with 96% handled on-site (i.e., the generators chose to treat or dispose of their own waste rather than sending it to an off-site commercial facility). Most of that waste (about 200 metric tons) was treated in surface impoundments and treatment tanks or through biological processes.117/ Several recent developments are likely to intensify the ongoing capacity problem. They are summarized below.

1. Shortage of Treatment and Disposal Capacity: RCRA's Land Disposal Ban and CERCLA's "Offsite Policy". The 1984 RCRA amendments, as noted in Part I, established a five-year phased ban on land disposal of specified hazardous wastes and set a series of deadlines for EPA issuance of regulations prescribing alternative methods for treating such wastes. Thus, implementation of the ban was predicated on the availability of preferred treatment options. Such options, however, have not materialized rapidly enough to facilitate the ban (see section 2, below). Therefore, EPA has been unable to fully meet either the first deadline (the ban on land disposal of certain untreated dioxin and solvent wastes, or the second deadline (the ban on land disposal of liquid hazardous waste containing PCBs and

halogenated organic compounds above certain concentrations). When those deadlines arrived, EPA imposed the bans as the statute required, but delayed their effective date for two years (except as to PCB-containing wastes), due to a shortage of incineration capacity. EPA further projects that it will be unable to meet the August 1988 deadline for banning disposal of other specialized wastes, including discarded commercial chemical products.118/

The capacity problem is enhanced not only by the land disposal ban but also by EPA's policy, codified in the 1986 CERCLA amendments, which prohibits offsite disposal of wastes removed from a contaminated site unless all waste management units at the offsite disposal facility are in full compliance with RCRA.119/ This policy, intended to ensure that wastes would not be removed from one leaking facility and placed in another, has substantially delayed cleanup activities at several sites, and several response actions have been halted entirely.120/

The policy creates an inconsistency in EPA's approach to hazardous waste management. Hazardous waste which is the byproduct of an industrial process may be disposed of in RCRA facilities that are temporarily out of compliance with the RCRA requirements; hazardous waste that is removed from a contaminated site may not be so disposed. To address this inconsistency, EPA may modify its CERCLA offsite policy to allow disposal of cleanup wastes at a facility that is temporarily out of compliance, so long as such disposal would not pose a threat to health or the environment. Such an approach would increase the disposal capacity for cleanup wastes -- a pressing need in light of the escalation in priority cleanup sites.

2. Delays in Permitting New Treatment and Disposal Facilities. It is apparent that the nation's treatment and disposal capabilities must be enhanced, in response to the land disposal ban and CERCLA's offsite policy. Nevertheless, the process of issuing permits to new facilities and to upgraded existing facilities tends to move at a snail's pace. This inevitable delay is attributable partly to RCRA's rigorous permitting requirements and procedures (discussed in Part I). Those problems are augmented by a range of other difficulties, which may be summarized as follows:

1. Corrective Action. Under RCRA's "corrective action" requirement, facilities that treat, store, or dispose of hazardous waste in landfills, surface impoundments, or similar units and have experienced groundwater contamination must submit cleanup plans with their permit applications. This requirement has created lengthy delays in the permit issuance process; EPA therefore has amended

its regulations so that, at the discretion of the permitting authority, some facilities may be allowed to develop or finalize their cleanup plans after issuance of their permits.121/

2. Public Opposition. Proponents of commercial offsite facilities generally encounter stiff opposition from local governments and area residents, who use statutory requirements as ammunition to delay project permitting. Such delays and augmented requirements may elevate development costs to such a level that project implementation becomes prohibitively expensive. These efforts are directed not only toward proposed new facilities but also toward retrofitting of existing facilities.

3. Jurisdictional Overlap. Overlapping authority with regard to regulation of hazardous waste units, among a wide variety of federal, state, and local government entities, frustrates the development of consistent permitting procedures and timeframes. In particular, local agencies with land use authority may seek to use those powers as a means of imposing environmental conditions on project development. The multiagency permitting framework also results in conflicting risk assessment policies. Thus, it is difficult for permit applicants to predict with reasonable accuracy either the costs or time entailed in obtaining the necessary permits to construct and operate a facility. These problems escalate for offsite facilities, because the public's involvement is likely to be greater; objections by local residents may become an issue in the on-site permitting process as well, however.

3. Belated Regulation of Municipal Landfills. Although local city landfills presumably are restricted to the disposal of so-called "nonhazardous" waste, it has recently become apparent that many of these landfills are the source of serious contamination problems and may pose a threat to local drinking water supplies. Of some 9300 landfills tested by EPA, almost 2300 had experienced releases to land, air, and water. In the past, municipal landfills have been subjected to minimal design and performance standards -- most have no liners or leachate collection systems, and very few use systems to monitor their impact on air, surface water, or groundwater or to measure the concentrations of gases such as methane escaping from the landfill. In response to these problems, EPA proposes to develop design and operating standards, including groundwater monitoring

requirements, siting criteria, corrective action requirements, closure and post-closure care standards, and air monitoring requirements.122/ The development and application of actual regulations, however, unquestionably will not be completed for some time in the future.

## D. Politicization of Hazardous Waste Issues

Policymaking administrative agencies such as EPA do not operate in a vacuum. The hazardous waste laws discussed in Part I are structured to maximize the oversight functions performed by Congress, state and local governments, the courts, and the general public. The involvement of legislators and other interested parties in the agency decisionmaking process is an inevitable consequence of the "balance of powers" established by the U.S. Constitution. At the same time, however, the detailed, specific mandates and deadlines which Congress has imposed on EPA in the environmental statutes obviously restrict the agency's flexibility in arranging its priorities and exercising its discretion. For example, the statutes may specify particular standards for particular pollutants, leaving little room for EPA to adjust the standards in response to particular problems in particular areas of the country. Moreover, these explicit requirements make the agency an easy target for concerned citizens who seek to influence the rulemaking process. As a consequence, that process is further impeded, and many of the rules that ultimately emerge (particularly under RCRA) are so tortured and convoluted that even the lawyers who drafted them do not fully understand them -- much less the regulated community.

Congress involves itself in the rulemaking process not only by enacting statutory mandates that dictate what rules EPA should make and when, but also by conducting "oversight hearings" in which it calls agency staff to testify about the rationales for particular regulatory decisions. This process further complicates the agency's ability to go about its work in a detached, objective fashion. Essentially, the rulemaking process begins to reflect political exigencies rather than sound technical and scientific policies. When agency decisionmakers shape their actions in ways calculated to avoid oversight hearings rather than create workable and effective regulations, the hard questions are not squarely addressed. Instead, the agency is likely to adopt whatever approach seems least susceptible to criticism from politically powerful forces.

As a related source of political pressure, most federal environmental statutes, including RCRA and CERCLA, authorize citizens to sue EPA if it fails to comply with congressional deadlines or other mandates. In addition, businesses subject to EPA's regulations may challenge its final rules in court, if the challenging company was a participant in the proceeding which led to those final rules. By some estimates, up to 80% of EPA's rulemaking decisions are challenged in court. Each challenge can produce three to five years of litigation, which usually resolves itself through multiparty settlement negotiations, including long debates among representatives of industry, environmental groups, and EPA. In the meantime, uncertainty as to the applicable standard delays the permitting process and related corporate spending decisions. Furthermore, in the event that no settlement is reached, the uncertainty is heightened by the prospect of a judicial decision. The agency, in effect, is caught in a three-way wrangle involving the legislators, the public, and the courts. Viewed in that light, it is not surprising that the EPA does not always make expeditions, well-reasoned decisions. Indeed, it sometimes seems remarkable that the agency produces any decisions at all.

It also is not surprising that EPA employee turnover, particularly in the Superfund program, tends to be high. A July 1987 draft report by the federal General Accounting Office found that the Superfund staff turnover rate more than doubled from fiscal 1985 to fiscal 1986 (from 2.9% to 7.2%), far exceeding the 5.2% rate for the federal government as a whole. EPA's difficulties in hiring and keeping qualified Superfund personnel, according to EPA employees surveyed for the report, resulted in widespread understaffing, which adversely impacted both the timing and quality of the agency's remedial action efforts. Major reasons cited for employee departures to the private sector were enhanced advancement and salary opportunities; EPA's pay scales reportedly lag 25 to 68% behind those for comparable nongovernment positions.

## III. FUTURE DIRECTIONS IN WASTE MANAGEMENT AND RELATED LIABILITIES

EPA, in a recent report addressing the problems arising from the lack of a coherent national solid waste management policy, concluded that future efforts should reflect the following priorities (in order of preference): (1) pursuing waste minimization and reduction incentives and techniques; (2) emphasizing waste recycling; (3) encouraging development of energy recovery facilities; (4) requiring sound land disposal practices; and (5) involving the states more directly in solid waste management planning and enforcement. Other areas in which some progress has been made include efforts to resolve the insurance crisis; a renewed emphasis on alternative dispute resolution techniques (i.e., alternatives to litigation); and a few encouraging measures to implement CERCLA's remedial action criteria and settlement provision.

## A. Waste Minimization, Recycling, and Alternative Treatment Technologies

1. Source Reduction, Recovery, and Reuse. Various waste reduction methods are available, ranting from process modification to volume reduction or recovery/reuse techniques. For example, companies using solvent-based paints, inks, and adhesives are seeking to develop water-based products to replace the solvent-containing materials, which generate both organic wastes and emissions. Physical modifications to increase the efficiency of production processes also may reduce waste generation, producing savings in both waste disposal and raw material costs.

Volume reduction techniques include separating the hazardous portion of a waste from the non-hazardous portion ("source segregation") and separating of wastes that can be recovered and reused from other process wastes. The use of filters to remove water from process wastes ("filtration") also may significantly reduce the volume of waste to be disposed. Water that is separated from the waste may be reused or discharged with little or no further treatment. Again, waste disposal costs are cut in proportion to the reduction in waste generated.

Recovery and reuse may be handled on-site, off-site, or through industry exchanges. An in-process recovery system entails the recovery and reuse of material lost during the process (e.g., metals lost during an electroplating or metal refining process), with accompanying reductions in raw material and production costs. If insufficient wastes are generated to make on-site recovery feasible, off-site recovery operations may be an alternative; if the materials recovered are useful to industries other than the company undertaking the recovery, an exchange may be appropriate.

2. Treatment Technologies. Many innovative approaches to waste treatment have sprung up in the past few years; the list below represents only a small sampling of potential options. Some are well-established, others are still on the drawing board.123/ (Aside from a brief mention of mobile incinerators, this discussion does not include incineration, since that method can no longer be considered "innovative.")

a. Bacteria Wastewater Treatment. Various companies are developing new lines of mutated and adapted bacteria specifically designed for solving problems in municipal waste treatment systems. These cultures generate biomass required for effective wastewater treatment, potentially improving good systems and making poor ones functional. The cultures, which attack biochemical oxygen demand, chemical oxygen demand, suspended solids, oil, grease, foam, and odor, are available in liquid or dry form and can be highly blended to handle toxic loading and shocks.

b. Kiln Dust Sludge Treatment. A recent Ohio demonstration established that a soil process using kiln dust or lime destroys pathogens and meets disinfection criteria. The process can be used to thicken, condition, dewater, fluidize, stabilize, and/or disinfect wastewater sludges with kiln dust, which is a co-product of the production of portland cement and lime.

c. Dioxin and PCB Detoxification. A cleanup in the state of Washington has adopted a new technique called potassium polyethelene glycol or "KPEG" for detoxification of dioxins. KPEG is a chemical process in which dioxin is heated and churned with a reagent, not an incineration process. The process strips the dioxin of chlorine ions and thus detoxifies it. About 12,000 gallons of material from the site were run through the process, which took about two weeks to complete. After treatment, the material was sampled and analyzed for dioxin and polychlorinated biphenyls (PCBs). The remaining hazardous constituents are to be incinerated.

d. Solidification/Stabilization. This technique is being used to remedy a Florida site which is contaminated with high concentrations of polychlorinated biphenyls. The site is located only five feet above an aquifer, which supplies all the water for the county. The solidification/stabilization process immobilizes the soil movement by solidifying soil particles and stabilizing them into a solid mass, through the use of a mixture of 40 percent cement and 60 percent fly ash. Since the solid mass is not expected to migrate, disposal will not require a liner. Monitoring will be required, however, to verify the operation's success.

e. Soil Vapor Extraction. Soil vapor extraction is being used at a Michigan well field site contaminated with volatile organic compounds. Vacuum wells generate a flow of air through the soil, pulling it into a carbon adsorption treatment system that removes the contaminants before they are released to the atmosphere. EPA believes that use of this process and concurrent groundwater treatment will remove 90% of the soil contamination and substantially reduce organics in the groundwater within three years, as opposed to the eight years that soil washing would require.

f. Radio Frequencies. The Illinois Institute of Technology has recently discovered that contaminated soil may be treated by heating the ground with radio frequencies. In this process, electrodes are placed on or just below the surface of the ground; at landfills, they are placed in deep bore holes. The soil is heated, water is boiled off, and toxic chemical vapors are collected in a tent. The remaining toxic material is incinerated on-site and shipped to permitted facilities, while the water is purified with carbon. According to the Institute, this process can extract more than 99% of toxic organic chemicals and could be used at up to 75% of contaminated sites. This method represents substantial savings over the soil removal and incineration approach and poses less of an exposure problem for workers. Since the equipment is mobile and hence reusable, further savings may be realized.

g. EPA's Mobile Incinerator. EPA derives a similar cost savings advantage from the use of its mobile incinerator, which can destroy PCBs, kepone, malathion, toxins, and other hazardous materials on-site. This technique eliminates the expense and the risk of transport followed by off-site treatment or disposal. The system is mounted on a semi-trailer that comes equipped with a rotary kiln, a second combustion chamber, and a gas scrubber.

## B. New Developments in Response to the Insurance Crisis

The drastically limited availability of liability coverage for environmental risks has generated proposed responses in two broad areas: alternative mechanisms to conventional insurance policies and legislative action to reform common law tort liability doctrines. Recent developments in these areas are summarized below.

1. Emerging Alternatives to Conventional Pollution Insurance Coverage. These options include three alternatives: "captive" insurance companies (also known as "risk retention groups" and "purchasing groups"), cooperative "reciprocal exchange" associations, and insurance pools. The 1986 CERCLA amendments specifically authorize the formation of risk retention and purchasing groups and encourage such groups by providing that, as long as they are licensed as an insurer in one State, they are exempted from other state restrictions.124/

a. Captives (Risk Retention and Purchasing Groups). In risk retention groups, companies form an association to establish pollution liability coverage for members. Thus, the "captive" insurance company provides insurance for the companies that organize it. Each member company pays a premium to join; the captive then uses these premiums to purchase insurance that would be too expensive for individual members. The benefits of association captives include (1) compensating for the unavailability of pollution insurance, (2) allowing improved loss control and loss prevention among member companies, and (3) providing for effective risk spreading and risk distribution. In addition, the association captive allows for broader coverage than a normal insurance contract and allows direct access to reinsurers.

An association captive may be difficult to establish; the group must have the capability to spread and distribute risks among numerous members (e.g., 30 companies). The group must develop uniform risk assessment procedures, determine whether premiums should be fixed or variable, provide the capability to secure reinsurance, ensure the confidentiality of financial data, and meet applicable state licensing requirements (as noted above, the CERCLA amendments have simplified the licensing process).

b. Reciprocal Exchange Associations. In these cooperative exchanges, the subscribing member companies insure one another. (The concept is similar to the London insurance syndicates, except that the insurance is for the benefit of the members, rather than nonmember third parties.) A basic contract among the subscribers defines the functions and structure of the organization. If an association consists of numerous members, it is managed by a separate corporation (an "attorney-in-fact"). This corporation serves as agent for the subscribers, in soliciting new members (companies needing insurance or insurers) and thereby selling insurance. This type of association, however, ordinarily is utilized by very large companies and insurers and would not be a readily available solution for smaller operations.

c. Insurance Pools. Another possible alternative to commercial pollution insurance entails setting up a pool of companies, probably in the same or related businesses, which use an underwriter to develop policies tailored to their needs. For example, policies could cover both "sudden and accidental" and gradual releases, with conditions reflecting the statutory and regulatory "financial responsibility requirements" applicable to hazardous waste management facility owners and operators. Other conditions might specify periodic risk assessments and adoption of stringent risk reduction measures.

2. Proposed Reforms in Liability Doctrines. As explained in Part II, the withdrawal of environmental impairment insurance reflects not only the statutory imposition of strict, joint and several liability for cleanup costs but also the common law doctrines which have extended the strict liability principle to the toxic tort context. In an effort to reverse this trend, actions have been pursued at both state and federal levels to enact statutes that would replace the judicially created tort doctrines and modify the rigorous cleanup cost liability framework.

a. Tort Liability Developments. In California, for example, the voters last year passed "Proposition 51", a ballot initiative creating a new law that limits the application of joint and several liability to a tort victim's lost wages and medical expenses. As to non-economic "pain and suffering" damages, which often escalate jury verdicts and settlements into the millions of dollars, individual defendants are liable only to the extent to which they are to blame for such damages (i.e., a single defendant cannot be held liable for pain and suffering damages which are attributable to the conduct of other defendants).

In the federal arena, the U.S. Attorney General in 1985 established a Tort Policy Working Group which developed a series of recommendations to address the insurance crisis.125/ The principal recommendations may be summarized as follows:

1. Retain fault (negligence) as the basis for liability (i.e., eliminate strict liability except as to its traditional application to abnormally dangerous activities).
2. Base causation findings on credible scientific and medical evidence and opinions.
3. Eliminate joint and several liability (some states have already adopted this approach; others utilize the "comparative fault" variation).
4. Limit non-economic damages (pain and suffering, punitive damages) to a fair and reasonable amount.
5. Provide for periodic payments of future economic damages.
6. Reduce awards by the extent to which the injury in question has already been compensated for by collateral sources.
7. Establish an attorneys' fee schedule that would provide for incremental reductions in contingency fees as the amount of the award increased.
8. Develop alternative resolution mechanisms.

Most of these recommendations have been incorporated into proposed (though not yet enacted) federal legislation that would supersede state liability and insurance law in that tort area. A recent congressional proposal included the following elements:

1. A return to fault-based liability. Product suits would be based in negligence unless the product was shown to be defective and unreasonably dangerous.

2. Restriction on joint and several liability except in concerted action cases (cases in which several defendants acted together in causing the harm).
3. Mandatory structured settlements for economic losses above $100,000.
4. Suspension of the collateral source rule.
5. Restrictions on contingent fee arrangements.
6. Caps of $100,000 on non-economic losses.
7. Encouragement of alternative dispute resolution.126/

All these proposals, however, have been attacked with great vigor by attorneys who specialize in representing tort plaintiffs. Because these attorneys have substantial political clout and financial support, their opposition thus far has proven successful, at least on the federal front.

b. Cleanup Cost Liability Proposals. Other proposals concerning environmental liability reforms have focused on the cleanup cost issues posed by the federal Superfund law (CERCLA) and analogous state laws. Key elements of these proposals (none adopted as yet) include limiting applicability of the "joint and several" doctrine; eliminating ongoing liability for hazardous waste cleanups by adopting a "channeling" approach that would extinguish a waste handler's liability at the point when waste was delivered to another handler (e.g., a disposal facility) in full accordance with applicable law (this approach would necessitate creation of a "safety net" to ensure that the last party in the chain could sustain the liability "channelled" to it); encouragement of voluntary private party cleanups, by providing for expedited governmental review and approval of private cleanup plans; and releases from future liability for parties who comply with an approved cleanup plan.

## C. Prospects for Reducing Litigation Through Alternative Dispute Resolution

EPA has recently endorsed guidance calling for the use of alternative dispute resolution ("ADR") in agency enforcement actions, so that claims alleging violations by the regulated community would be addressed with the aid of neutral third parties rather than in the courtroom. ADR previously has been used by EPA in negotiated rulemaking efforts, in hazardous waste facility siting disputes under RCRA, and in remedial action disputes under CERCLA, but has never been applied in the enforcement context until now. Two principal reasons for EPA's decision to look to ADR in enforcement matters are the expense of enforcement litigation and the desire to encourage public involvement in action to enforce cleanup remedies.

EPA seeks to invoke ADR as early as possible in case development. Its guidance on the use of ADR includes ADR selection and approval procedures; procedures and criteria for selecting and compensating the third-party neutrals; and sample ADR agreements. The guidance describes the major available ADR techniques -- mediation, arbitration, fact-finding, and mini-trials -- as follows.127/

1. Mediation. Mediation is the facilitation of negotiations by a person not a party to the dispute (herein "third-party neutral") who has no power to decide the issues, but whose function is to assist the parties in reaching settlement. The mediator serves to schedule and structure negotiations, acts as a catalyst between the parties, focuses the discussions, facilitates exchange between the parties, and serves as an assessor -- not a judge -- of the positions taken by the parties during the course of negotiations. With the parties' consent, the mediator may take on additional functions such as proposing solutions to the problem. Nevertheless, as in traditional negotiation, the parties retain the power to resolve the issues through an informal, voluntary process, in order to reach a mutually acceptable agreement. Having agreed to a mediated settlement, parties can then make the results binding.

2. Arbitration. Arbitration involves the use of a person -- not a party to the dispute -- to hear stipulated issues pursuant to party-specified procedures. Depending upon the agreement of the parties and any legal constraints against entering into binding arbitration, the decision of the arbitrator may or may not be binding. All or a portion of the issues -- whether factual, legal or remedial -- may be submitted to the arbitrator. Because arbitration is less formal than a courtroom proceeding, parties can agree to relax rules of evidence and utilize other time-saving devices. The Government, however, is currently restricted by law to use binding arbitration only for factual issues.

3. Fact-Finding. Fact-finding entails the investigation of specified issues by a neutral

with subject matter expertise, and selected by the parties to the dispute. The process may be binding or nonbinding, but if the parties agree, the material presented by the fact-finder may be admissible as an established fact in a subsequent judicial or administrative hearing, or determinative of the issues presented. As an essentially investigatory process, fact-finding employs informal procedures. Because this ADR mechanism seeks to narrow factual or technical issues in dispute, fact-finding usually results in a report, testimony, or established fact which may be admitted as evidence, or a binding or advisory opinion.

4. Mini-Trials. Mini-trials permit the parties to present their case, or an agreed upon portion of it, to principals who have authority to settle the dispute (e.g., vice-president of a company and a senior EPA official) and, in some cases as agreed by the parties, to a neutral third-party advisor. Limited discovery and preparation precede the case presentation. The presentation itself is an abbreviated hearing with testimony and cross-examination as the parties agree. The principals are the decisionmakers, while the third-party neutral, who usually has specialized subject matter expertise in trial procedures and evidence, acts as an advisor on potential rulings on issues if the dispute were to proceed to trial. Following the mini-trial, the principals reinstitute negotiations, possibly with the aid of the neutral as mediator. This ADR mechanism is useful in narrowing legal and factual issues in a dispute, and in giving the principals a realistic view of the strengths and weaknesses of their cases.

## D. EPA Initiatives to Facilitate Remedy Selection and Settlement Processes

EPA, fully cognizant of the additional costs generated as a result of delays in selection of remedial actions and negotiation of multiparty settlements, has moved ahead on several fronts to address those problems. Recent actions include (1) the targeting of areas that demand close attention in the NCP revision and Superfund settlement processes and (2) the development of initial guidance on remedy selection and settlement issues.

1. Targeting of NCP and Revision and Settlement Problems. EPA, in early 1987, singled out the following concerns as critical to the NCP revision process and identified approaches to address them:

1. Selection of remedy ("how clean is clean"). To implement CERCLA's new and controversial cleanup standards, EPA staff will be discussing the definition of "permanent" cleanups mandated by the new law, including the definition of "permanence", and how that definition differs from that of "protective." Definitions of "maximum extent practicable" will also be discussed, specifically the role of cost, and how the permanence or long-term effectiveness of a cleanup can be measured.

2. ARARs ("legally applicable or relevant and appropriate requirements"). EPA will focus on the issue of how "applicable" and "relevant and appropriate" standards will be defined, and apparently will reference some ARARs as illustrative but will not actually include them within the revised NCP.

3. Removals. EPA must determine how and whether CERCLA's new provisions limiting the amount to be spent on removals and the time for such actions (from $1 million to $2 million and from 6 to 12 months) will be specified in the NCP; and whether the NCP preamble should define when removal action should be undertaken.

4. State involvement. EPA will attempt to define in the NCP at what points in the remedial action process the state should be consulted. The definition of what constitutes prompt notice of proposed action in the states, both to EPA and the states, will also be considered, and how EPA can ensure adequate state involvement while also ensuring a timely response. The role of states in listing sites on the NPL is another issue before EPA.

5. Health related authorities. EPA will explore how to coordinate CERCLA's new requirements for health assessments with other remedial activities without interfering with the mandatory statutory

deadlines. One issue is the extent to which health assessments will determine the appropriate level of cleanup.

6. Remedial site evaluation (preliminary assessments/site inspections, National Priorities List). Major issues include setting guidelines to be followed by members of the public seeking to petition EPA to conduct a preliminary assessment at a site.

7. CERCLIS (EPA's computerized list of candidate NPL sites and reported releases). EPA will define the computerized listing of all sites/releases to avoid making the agency liable for preliminary assessments for all removal sites.

8. Hazard ranking system. EPA plans to evaluate how the hazard ranking system used to determine whether a site should be placed on the NPL should be addressed in the body of the NCP.128/

Also in early 1987, EPA identified three settlement procedure areas in need of reform and proposed specific improvements:

1. Preparation for Negotiations. EPA has encountered problems when it does not fully prepare itself for negotiations or facilitate preparation of potentially responsible parties (PRPs). EPA believes that its negotiating teams should have a strategy for settlement which "addresses goals, interim milestones for continuing negotiations, firm schedules and follow-up steps in the event settlement is not achieved." EPA also encourages PRP assistance, claiming settlement efforts have been more successful where EPA has assisted in forming PRP steering committees and giving early notice. The agency suggests that regions improve negotiation preparation through four activities: (1) earlier, better searches for available PRPs; (2) earlier notice and information exchange; (3) earlier initiation of discussions; and (4) earlier strategy preparation and draft settlement documents. EPA has found that inadequate information on the identity of PRPs and their contributions can be a "significant impediment to PRPs organizing themselves to present an offer of settlement." EPA plans to hire in-house civil investigators who will be available to regions to ensure appropriate contractors are contacted for PRP searches. EPA also plans to have headquarters staff revise the "potentially responsible party search

manual." EPA also urges the regions to initiate notice to PRPs of potential liability and information requests as early as possible.

2. EPA Management Review of Settlement Decisions. EPA has found that delays in the management review process can be a "major impediment to settlement," and suggests that inaccessibility of decisionmakers, failure of negotiating teams to raise issues to management early in the process, and requiring that decisions be made by high-level management are accountable for breakdowns in settlement decisions. To help improve management review, EPA has outlined roles in the decision process, and has added two new elements to focus policy review: a new settlement decision committee and the assistant administrator level review team. EPA intends to maintain its negotiation team to review various aspects of settlement negotiations, composed of EPA representatives, members of the Justice Dept. and state representatives, if necessary. The regional administrators, in consultation with the Justice Dept., will be the primary decisionmaker on Superfund settlement issues. However, certain major or precedential issues in remedial design/remedial action negotiations will be referred for early headquarters resolution. Such issues include: mixed funding or preauthorization arrangements; broad releases; de minimis settlements; deferred payment schemes; and remedies that deviate significantly from the record of decision (ROD). EPA plans to develop an oversight program to ensure consistency in regional program administration, and plans to delegate significant planning authority to the regions. EPA expects eventually to act in a mainly advisory role to the regions, providing guidance as necessary. The settlement decision committee has been established to coordinate decisions on policy issues raised by regions, and monitor regions' progress in settlement negotiations.

3. Establishment of Negotiations Deadlines. Though Superfund cases involve many parties and complex legal issues, EPA will establish guidelines for resolving issues so cleanup at the site is not unnecessarily delayed. EPA has outlined a framework for considering extension of discussions "beyond the statutory moratorium period," with an initial extension by the region and possibly a further extension by headquarters.129/

2. Interim Guidance on Remedy Selection, De Minimis Contributors, Mixed Funding, and Covenants Not To Sue. EPA has issued the following guidance on four basic criteria which the regional staffs should apply in choosing among alternative remedial actions to be applied at particular sites:

1. Remedies must be protective of human health and the environment. This means that the remedy meets or exceeds ARARs, or health-based levels established through a risk assessment, when ARARs do not exist.

2. Remedies should attain federal and state public health and environmental requirements that have been identified for a specific site. In general, the remedy selection process presumes that alternatives will be formulated and refined to ensure that they attain all of the appropriate ARARs. However, Superfund provides waivers which permit selection of remedies which do not attain all ARARs under six different types of circumstances: fund-balancing, technical impracticability, interim remedy, greater risk to health and the environment, equivalent standard of performance, and inconsistent application of state standards. If a remedy is protective, cost-effective, and adequately satisfies the statutory preferences, inability to attain a particular ARAR will not necessarily prevent selection of that alternative if it was viewed as the all-around best remedial alternative.

3. Remedies must be cost-effective. In general, this finding requires ensuring that the results of a particular alternative cannot be achieved by less costly methods. This implies that for any specific site there may be more than one cost-effective remedy, with each remedy varying in its environmental and public health results.

4. Remedies must use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. This determination is interrelated to the cost-effectiveness finding and includes consideration of technological feasibility and availability.130/

EPA also has issued guidance on providing separate settlements for "de minimis" contributors. As noted in Part II, the settlement criteria are too general to represent meaningful standards. Further, EPA's unwillingness to commence de minimis settlement negotiations before completion of the RI/FS process undermines one of the basic objectives for de minimis settlors: avoiding the transaction costs inherent in participation in the lengthy RI/FS undertaking. Nonetheless, the guidance represents one step toward curtailing an unfair side effect of Superfund's sweeping liability scheme, i.e., the involvement of de minimis parties in the costly remedial action process and associated litigation.

Another crucial innovation endorsed by the Superfund amendments, the "mixed funding" approach, also has been the subject of tentative implementation efforts by EPA. Under the mixed funding concept, each available PRP pays a share of the costs in proportion to its contribution to the contamination and EPA uses the Superfund to pay the shares of parties who are unavailable or insolvent. Two formal "mixed funding" settlements had been completed as of July 1987. In these settlements, EPA expressly authorized the use of specified amounts from the Superfund to finance a predetermined percentage of cleanup costs at the sites. This division of payment obligations among the Fund and PRPs was then formalized in a consent decree, which was lodged with a court and hence subject to enforcement in the event of breach.

EPA also has issued interim guidance on implementation of Superfund's provision allowing for covenants not to sue, i.e., releases from future liability for cleanup costs in settlements of EPA cost recovery actions against PRPs. One key problem with the statutory provision, from the standpoint of facilitating settlements, is the requirement for liability "reopeners" in the event that unknown conditions or new information create a danger that warrants further expenditures. While EPA's guidance offers positive encouragement on the prospect of timely cleanup certification, which is essential for a release to become effective, it complicates the controversial reopener issue by suggesting that reopeners will cover not only unknown conditions but also situations where the original remedy appears inadequate to fully protect public health or the environment.131/ Thus, the availability of releases may not serve to generate speedier settlements.

## IV. CONCLUSION

To a significant degree, the nation's ongoing problems in seeking a waste management system that will be truly "manageable" are a function of numerous uncertainties. Unresolved issues include, e.g., how to accurately estimate the effect of contaminants, at varying concentrations and in different media, on human health; how to expedite commercial availability of cost-effective and functional treatment technologies; how to ensure the rapid transmittal of accurate data about site conditions to PRPs and the public; how to minimize duplicative, time-consuming permitting and cleanup activities by federal, state and local agencies; how to involve the public and political entities in siting and cleanup in a positive rather than an adversarial role; and, perhaps most important, how to expedite the development of clear and workable standards and procedures to be applied in the siting, remedy selection, and settlement processes. Substantial progress has been made in all these areas, over the past several years, but much remains to be done. Our shrinking waste management capacity, coupled with escalating discoveries of contaminated sites, accentuate the urgency of prompt action to arrive at acceptable answers to the hard questions.

## TABLE OF ABBREVIATIONS

ADR - alternative disute resolution

ARARs - legally applicable or relevant and appropriate standards (determine the level of treatment needed or particular contaminants at cleanup sites)

CERCLA - Comprehensive Environmental Response, Compensation and Liability Act (the Superfund law)

CERCLIS - Comprehensive Environmental Response, Compensation and Liability Information System

C.F.R. - Code of Federal Regulations

CGL - comprehensive general liability

EIL - environmental impairment liability

EPA - U.S. Environmental Protection Agency

HRS - Hazard Ranking System

NCP - National Contingency Plan

NPL - National Priorities List

PRP - potentially responsible party (with regard to cleanup cost liability)

RCRA - Resource, Conservation and Recovery Act (solid and hazardous waste management law)

RI/FS - remedial investigation and feasibility study (data to serve as basis for remedy selection)

SQG - small quantity generator

TSDF - treatment, storage, or disposal facility (*i*.*e*., hazardous waste management facility)

U.S.C. - United States Code

## FOOTNOTES

1/ RCRA, enacted in 1976 with major amendments in 1978 and 1984, is found at 42 United States Code §§ 6901 et seq. CERCLA, enacted in 1980 with major amendments in 1986, is found at 42 United States Code §§ 9601 et seq.

2/ 42 U.S.C. § 6929. Authorization is granted on a phased basis. A state first obtains "interim" authorization; when EPA has fully approved of its RCRA program, it obtains "final" authorization.

3/ 42 U.S.C. § 6941.

4/ 40 Code of Federal Regulations §§ 261.2 and 262.3. A federal appellate court recently overturned EPA's definition of solid waste, found in these regulations; if that decision is not reversed by the Supreme Court, EPA will have to modify its regulation. See American Mining Congress v. United States Environmental Protection Agency, Nos. 85-1206 through 1208 (D.C. Cir. July 31, 1987).

5/ 40 C.F.R. § 261.2(a).

6/ See 40 C.F.R. Part 262.

7/ Id.

8/ See 40 C.F.R. Part 263.

9/ Id.

10/ Id.

11/ 42 U.S.C. § 6925(i).

12/ 40 C.F.R. §§ 265.70-77.

13/ 40 C.F.R. §§ 265.110-150.

14/ 42 U.S.C. § 6924(u).

15/ 42 U.S.C. § 6903(27) and (28).

16/ Id.

17/ 42 U.S.C. § 6924(v).

18/ 40 C.F.R. § 270.10(f)(2).

19/ 40 C.F.R. §§ 170.03-31; 264.50-56, 110-120, and 140-151.

20/ 42 U.S.C. § 6924(d) and (e).

21/ 42 U.S.C. § 6924(d)(1).

22/ 42 U.S.C. § 6930(a).

23/ 42 U.S.C. §§ 6935 and 6924(q)(1).

24/ 42 U.S.C. § 6991(2).

25/ 42 U.S.C. § 6991(2), 40 C.F.R. § 302.4.

26/ 42 U.S.C. § 6991a(a).

27/ These regulatory programs are required under 42 U.S.C. § 6991b; the tank cleanup program, in section 6991b(h), was added as part of the 1986 bill amending CERCLA.

28/ 42 U.S.C. §§ 6945(c) and 6949(c).

29/ 42 U.S.C. §§ 6943(c) and 6948.

30/ 42 U.S.C. §§ 6945(a) and (c), 6972, 6927, 6928.

31/ 42 U.S.C. §§ 6926-28 and 6972.

32/ 42 U.S.C. § 6903(15).

33/ See, e.g., United States v. Liviola, 605 F. Supp. 96 (N.D. Ohio 1985).

34/ 42 U.S.C. §§ 6928(a)(1) and (g); 6972(a).

35/ 42 U.S.C. § 6928(h)(1).

36/ 42 U.S.C. § 6928(c).

37/ 42 U.S.C. § 6928(f)(4).

38/ 42 U.S.C. § 6927(a).

39/ 42 U.S.C. § 6927.

40/ Id.

41/ Id.

42/ 42 U.S.C. § 6928.

43/ Id.

44/ 42 U.S.C. §§ 6972 and 6976.

45/ The Fund is sustained by an excise tax on petroleum and feedstock chemicals, a tax on imported chemical derivatives, an "environmental" tax on corporate minimum taxable income in excess of $2 million, an appropriation from general resources, and monies from cleanup cost recoveries, with associated interest and penalties. The taxes are imposed by the Superfund Revenue Act of 1986, set forth in section 59A of subchapter A, chapter 1 of the Internal Revenue Code of 1986.

46/ 42 U.S.C. § 9607(a).

47/ 42 U.S.C. § 9606.

48/ 42 U.S.C. §§ 9611-12, 9607(a).

49/ 42 U.S.C. § 9605. The list is set forth at 40 C.F.R. Part 300, Appendix B.

50/ 40 C.F.R. § 300.66 and Appendix A to Part 300.

51/ 42 U.S.C. § 9603(a).

52/ A second notification requirement applies to owners or operators of hazardous waste management facilities which lack interim status or RCRA permits; such persons were required to notify EPA of the facilities' existence within 6 months after December 11, 1980. 42 U.S.C. § 9603(c).

53/ 42 U.S.C. § 9601(14).

54/ 40 C.F.R. Part 32, Table 302.4.

55/ 42 U.S.C. § 9601(21).

56/ 42 U.S.C. § 9607(a).

57/ It is crucial to recognize that the owner/operator concept has been construed very broadly by the courts, in the context of actions brought against PRPs to enforce the law and recover cleanup costs. Under these decisions, a liable "owner" may include a landlord whose tenant caused contamination, though the landlord had no involvement in the tenant's operation; an individual corporate manager or officer, though such individuals did not know of the activities by their employees which caused contamination; an individual whose sole link to the operation causing the contamination is that of a partner or joint venturer; a city which hired a private company to run the local landfill and was unaware of the operator's poor disposal practices; a company which takes over another company (a "successor in interest"); and even a lending institution which forecloses on a contaminated site and thus acquires legal title. The statute specifies, however, that a creditor who takes no part in managing the facility and holds "indicia of ownership" primarily to protect his security interest is not an "owner" (and hence is not a PRP). 42 U.S.C. § 9601(20)(A).

58/ 42 U.S.C. § 9607(a).

59/ 42 U.S.C. § 9607(c)(2).

60/ 42 U.S.C. § 9607(c)(3).

61/ These defenses are extremely limited. The "intervening third party" defense, for example, is available only if an unforeseeable event (which would not necessarily include burglary or vandalism) causes a release and the facility owner or operator has taken all reasonable precautions to prevent such release. Similarly, a landowner is "innocent" only if he undertook a reasonable investigation (at a minimum, a site history) before acquiring the property and found no evidence to suggest a possible contamination problem. See 42 U.S.C. §§ 9601(35) and 9607(b).

62/ 42 U.S.C. §§ 9604, 9606-07, 9611, 9613, 9623.

63/ 42 U.S.C. §§ 9604, 9606-07.

64/ 42 U.S.C. § 9601(33).

65/ 42 U.S.C. § 9604.

66/ Id.

67/ Id.

68/ Id.

69/ Id.

70/ 42 U.S.C. § 9611(c)(9).

71/ 42 U.S.C. § 9604.

72/ 42 U.S.C. § 9604.

73/ 42 U.S.C. §§ 9605 and 9621. The NCP is found at 40 C.F.R. Part 300.

74/ 42 U.S.C. § 9604.

75/ 42 U.S.C. §§ 9613(k)(2) and 9617.

76/ 42 U.S.C. § 9617.

77/ 42 U.S.C. § 9659.

78/ 42 U.S.C. § 9621.

79/ 42 U.S.C. § 9605(10).

80/ 42 U.S.C. § 9621.

81/ *Id*.

82/ *Id*.

83/ *Id*.

84/ 42 U.S.C. § 9616.

85/ 42 U.S.C. § 9606.

86/ 42 U.S.C. § 9622.

87/ 42 U.S.C. § 9607.

88/ *Id*.

89/ *Id*.

90/ 42 U.S.C. § 9622.

91/ *Id*.

92/ *Id*.

93/ *Id*.

94/ *Id*.

95/ *Id*.

96/ 42 U.S.C. §§ 9604(e), 9609(c), and 9659(a).

97/ 42 U.S.C. § 9609(a) and (b).

98/ 42 U.S.C. §§ 9603(d) and 9606(b).

99/ 42 U.S.C. §§ 9603, 9604, 9608, and 9622.

100/ 42 U.S.C. § 9604.

101/ 42 U.S.C. § 9609.

102/ 42 U.S.C. § 9604.

103/ 42 U.S.C. § 9610.

104/ 42 U.S.C. §§ 9604, 9606, 9609, and 9622.

105/ 42 U.S.C. § 9609.

106/ Id.

107/ 42 U.S.C. § 9659.

108/ CERCLA's new settlement policy, with the potential for releases from contribution liability, may make this situation somewhat less unfair, but will not do much to alter insurer aversion to offering EIL policies.

109/ See, e.g., Port of Portland v. Water Quality Ins. Syndicate, 796 F.2d 1188 (9th Cir. 1986); Great Lake Container v. National Union Fire Ins. Co., 727 F.2d 30 (1st Cir. 1984).

110/ See, e.g., Shapiro v. Public Service Mutual Ins. Co., 477 N.E. 2d 146 (Mass. App. 1985); State of Ohio v. The Buckeye Union Ins. Co., 477 N.E. 2d 1227 (Ohio App. 1984).

111/ Memorandum on RI/FS Improvements, Henry L. Longest, Director, EPA's Office of Emergency and Remedial Response (July 1987).

112/ A classic illustration of the problems posed by the convoluted RI/FS process is represented by a cluster of contaminated sites in California's Silicon Valley, home of the high-tech industry, well-known for its history of improper practices in hazardous waste management and disposal. After over four years and $20 million in investigation costs, these facilities recently delivered to EPA their completed Remedial Investigation Report -- eight volumes long and some 3 1/2 feet thick. The second part of the analysis -- the "feasibility study" comparing proposed remedial alternatives -- is yet to be performed. The companies have independently commenced actions to contain the spread of contamination while the RI/FS is in progress, but actual selection and completion of the preferred remedial action does not appear imminent.

113/ A case in point is that of Stringfellow Acid Pits, a leaking hazardous waste landfill in southern California for which cleanup costs are expected to approach $100 million. The federal government sued some of the generator and transporter PRPs about 5 years ago; the PRP defendants in turn sued other PRPs; and the judge finally ruled this spring that the generators who lawfully deposited waste at the state-approved site nonetheless are liable for the cleanup costs. The judge further ruled that it was impossible to allocate responsibility for contamination on a percentage basis among the various defendants, because the wastes had "commingled" over a long period, and that joint and several liability therefore applied. Also held liable were the site's original owners (a quarry company) and the present owners of a portion of the dump.

114/ *See* 52 Federal Register 24333-24339 (June 30, 1987).

115/ Office of Technology Assessment, *Superfund Strategy*, 125 (1985).

116/ Gene A. Lucero, Director of Office of Waste Programs Enforcement, EPA, quoted in 17 Environment Reporter (BNA) 779 (1986).

117/ EPA, *The Hazardous Waste System* (1987).

118/ *Inside EPA* (August 21, 1987).

119/ 42 U.S.C. § 9621(d).

120/ *Environment Reporter* (BNA), July 24, 1987, 846-47.

121/ *See* 52 Federal Register 23447 (June 22, 1987).

122/ *Inside EPA* (July 31, 1987).

123/ Most of the items below are based on reports in BNA's *Air & Water Pollution Control Reporter* for 1/14/86, 1/15/87, and 7/15/87 and the *Hazardous Waste Report* for 8/17/87.

124/ 42 U.S.C. §§ 9671-75.

125/ *Report of the Tort Working Group on the Causes, Extent and Policy Implications of the Current Crisis in Insurance Availability and Affordability*, Op. Off. Att'y Gen. (Feb. 1986).

126/ Goldberg, "Manufacturers Take Cover," *American Bar Association Journal*, July 1, 1986, at 55.

127/ Excerpted from EPA's draft ADR guidance, released February 1987 and approved August 1987.

128/ EPA's draft "Development Plan for the National Contingency Plan", January 1987.

129/ EPA Memorandum on Implementation of Superfund Amendments, J. Winston Porter and Thomas L. Adams, February 1987.

130/ EPA Guidance on New Superfund Cleanup Standards, Assistant Administrator J. Winston Porter, January 1987.

131/ 52 Federal Register 28038 (July 27, 1987).

# LEGITIMIZED STRUCTURED PUBLIC INVOLVEMENT IN THE ENVIRONMENTAL ASSESSMENT PROCESS

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## INTRODUCTION

In this paper I propose to outline a model of Environmental Mediation that is intended to:

1) advance public acceptability of the regulatory process;

2) reduce the cost of Environmental Assessment Hearings;

3) allow the process to become more consensual and less litigious. This paper is most relevant in those jurisdictions which has an adjudicative or quasi adjudicative hearing structure. However, with some alterations, it can be applied to a more administrative structure.

__Labour Analogy__. My interest in this subject arose primarily as a result of some observations made in my private law practice. For a number of years, I have represented both unions and management in labour relations. Labour relations is a highly structured system designed to faciliate and legalize relations between employers and employees. Most Labour Relations Acts in Canada define an elaborate scheme of union certification, maintain employee rights during certification, and regulate the bargaining that results in a Collective Agreement. These Acts can be described as establishing and maintaining bargaining relationships. These relationships, once established, will continue for an indefinite period of time.

It is inevitable that when the Collective Agreement is being negotiated for the first time or renegotiated in later years, potential for conflict and dispute will develop. The traditional solution to resolving labour disputes has been the strike or lock-out. Labour legislation tries to interpose other conflict resolution methods prior to allowing the parties to invoke such sanctions. Before a strike or lock-out can occur, certain processes must be completed, most noteworthy of which is what Suskin and Madigan define as traditional or passive mediation. This is much like collaborative problem solving where the process tries to generate solutions. There is considerable reliance on the assistance of a conciliator or mediator. No party can invoke more serious sanctions until conciliation has been exhausted.

In this context of private, contractual dispute resolution, the parties are easily identified; relationships are clearly defined and the rules of the game are spelled out and understood by all before hand. Again, in a labour dispute, only the parties represented at the table need to agree to ensure a reasonably stable agreement.

Labour Relations, despite its chaotic appearance to outsiders, is highly structured, regulated and for the most part predictable. The parties have a stake in the proceedings and are interested in making sure that a sincere effort is made to resolve their differences through conciliation/mediation. The price of failure can be expensive and in some cases, extremely damaging.

Environmental Regulation. Consideration was given to the question could a process appropriate for private dispute resolution be applied to what was essentially a regulatory process that controls or licenses persons or firms whose activities may have environmental consequences. The answer is a qualified yes.

The Public Interest. The test for the granting of an operating licence by a regulatory body is whether the proposed operation is in the public interest. One can see from an examination of some agencies such as the C.R.T.C., various Energy Boards or Highway Traffic Boards, that the dilineation of the public interest gets to be defined by the Board and the various adverse parties, sometimes called "objectors" or "interested parties", who participate in the proceedings. The objectors have a recognized and accepted role in the regulatory process. They may be competitors of the applicant or they may be members of the public who believe that the proposal is not in the public interest for various reasons that are personal or philosophical. In environmental matters the same considerations apply. In very few cases will the objectors be competitors, although the O.W.M.C. has been seen to attend at applications in Ontario of competitors, ostensibily as an "observer". In the Environmental area as in the longer established regulatory areas , the objectors are usually well organized and funded permanent interest groups or ad hoc local interest groups sometimes describing themselves as an Anti-Pollution Association. In addition, there may be independent or local objectors. These parties, by participating at hearings seek to influence the granting of the licence or certificate, assist in defining the public interest and ultimately influence the conditions governing the carrying on of the environmental activity.

Desire of Parties. Apart from the major dilemna that no one wants a waste disposal facility in their neighbourhood, it is apparent to most observers that agreement can be reached on many of the Environmental issues without a hearing, yet hearings do ensue which are arduous, lengthy, expensive, time consuming and ultimately, not responsive to the concerns of the public objectors. The hearing process involving as it does lawyers and experts has tended to take on very pronounced adversarial qualities. The Hearing Board ("Board") is hampered in granting concessions to objectors unless serious flaws are apparent in the Application being made by the proponent. In hearings, potential exists for disaffection because of perceived ineffective public participation.

In designing a mediation process for environmental matters some practical difficulties that would have to be canvassed. These include the multiplicity of issues, the many parties with no common basis of compromise, and a proponent impatient with procedural or other delays. These do not constitute inherent impediments to mediation. I submit that proponents in principle want to engage in dialogue with the public; most proponents, whether they are municipalities or private companies are conscious of Environmental concerns and want to deal with them. There is a sincere desire on the part of the proponents to establish a dialogue with objectors which can lead to compromise. It is my impression that proponents don't like the hearing process especially, but view it as being the only vehicle for obtaining an approval or license. For these reasons, I submit that both objectors and proponents would like to escape from the confines of a process which is inherently unsatisfying to them both. Despite the apparent utility of Environmental Mediation it is not in wide spread use. A strategy to broaden its limited use is the focus of this paper.

## THE LEGISLATIVE FRAMEWORK

While most participants in the Environmental process agree that mediation or conciliation of some sort would be helpful, there is no Environmental statute in Canada that legitimizes or authorizes mediation. I would submit that if the parties to the process are to develop some awareness of the potential for improved conflict resolution through mediation, then a legislative basis for mediation should be established.

By way of example, Labour Relations Legislation in Ontario allows the trade union or employer to make a request for a conciliator. Upon such request being made the Minister must "appoint a conciliation officer to confer with the parties and endeavour to effect a collective agreement". The scheme of conciliation and mediation is described in some twenty sections of the Act. It is clear that a first step in promoting mediation and giving it an aura of legitimacy would be in recognizing mediation specifically in the Environmental Protection Act or the Environmental Assessment Act. An enabling section might read as follows:

1) "Where an application has been filed under Section ___ of the Environmental Protection Act, the Minister, upon the request of the Applicant or any party to the proceedings, shall appoint a case officer to confer with the parties and endeavour to settle any differences between the parties.

2) Where a case officer is appointed, he shall confer with the parties and endeavour to effect a settlement of the

differences between the parties and he shall within _____ days of his appointment report the result of his endeavours to the Minister.

3) The period mentioned in sub-section 2 may be extended by agreement of the parties by the Minister upon the advice of the case officer that a settlement may be achieved within a reasonable time if the period is extended.

4) Where the case officer reports to the Minister that the differences between the parties with respect to the Application have been settled, the Minister shall forthwith by notice in writing inform the parties of the report.

5) No person shall act as a case officer who has any pecuniary interest in the matters coming before him or who is acting or has within a period of six months preceding the date of his employment acted as a solicitor counsel for agent of any of the parties."

Legislative provisions similar to these would provide a suitable basis for statutorily authorized mediation. The mediator is given the title Case Officer. There is no inherent magic to the term except that any title enhances the stature of the role. By avoiding the usual term of conciliator or mediator, it is sought to encourage a broad perception of the officer's duties. The case officer ought to be appointed by and report to the Minister. It is essential that the case officer not be seen to be part of the proceedings of the Environmental Assessment Board. Whatever information he receives, or whatever statements he makes, will ultimately be privileged. Every party should have absolute confidence that whatever it says to the case officer during negotiatons will not be divulged to the Minister or the Board. In this regard, a provision could be added to the effect that "no case officer appointed by the Minister shall be required to give testimony in any civil suit or in any proceeding before the Environmental Assessment Board or any proceeding before any other Tribunal respecting information obtained in the discharge of his duties or while acting within the scope of his employment under this Act."

## THE CASE OFFICER CORPS

Environmental Mediation has been described by Gerald Cormick as "a voluntary process in which those involved in a dispute jointly explore and reconcile their differences. The mediator has no authority to impose a settlement. His or her strength lies in the ability to assist the parties in resolving their own differences".

Qualifications and Skills. The mediator is viewed as being an outside neutral third party and usually has a body of technical expertise in an area or areas germaine to the dispute. The mediator is utilized to suggest solutions to what otherwise may be irreconcilable differences. The mediator must have the complete trust and confidence of all parties to the issue. These criteria require the mediator be financially independent of all interests represented by the various parties.

As one explores the selection criteria for a case officer or mediator, one can isolate some of the difficulties associated with the task. First, the case officer should have some expertise in the subject matter of the application. He should have some general familiarity with the scientific issues and Environmental concerns raised by the Application. Second, the case officer should have some background in interactive conflict resolution whether as an advocate, manager or even as a conciliator in some other field. He would ideally have experience in the regulatory process and have been exposed to consensus building activities in related fields. The profile of an appropriate mediator suggests that he has acquired related experience and either enjoys the confidence of the parties or is a person who will quickly acquire such confidence after an initial series of meetings.

Process Impediments. Some observers such as John Wilms' writing in the Spring, 1986, Canadian Environmental Mediation Newsletter, suggest that the major opposition to mediation will come from lawyers. Mr. Wilms says that a lawyer views mediation as a method whereby his client's case would be exposed to the opposition in a piece meal process and would thereby be emasculated. If parties to mediation are represented by lawyers, it is probably necessary and essential that the case officer be able to speak to lawyers in language that they will understand and appreciate. For mediation to work, apart from anything else that will be said in this paper, the case officer must have the skill to create a climate in which the parties and their representatives will come to respect him enough to engage in a free and frank exchange of information. To give you some indication of the dimension of this problem, I quote from Mr. Wilms' article:

"One important weapon in a litigation lawyer's arsenal is surprise. In my opinion, the element of surprise is of little or no utility in Environmental and planning lawsuits and hearings. Nonetheless most lawyers will fight long and hard to avoid divulging all but those elements of the case which must by reason of production and discovery law be revealed. One reason a lawyer believes that mediation cannot possibly occur without prejudice to the client's position, is that mediation forces a fairly direct and frank exchange of important information and opinions before the hearing in a setting that is beyond the lawyer's control".

## BRINGING THE PARTIES TOGETHER

Recently there has been considerable effort by the Environmental Assessment Board in Ontario to codify rules of procedure and practices which it has utilized in an informal way over the past few years. Interestingly enough, the draft rules focus on what is known as a "pre-hearing conference". While the rules have not as yet been officially promulgated, the drafts suggest that this conference would take place in the presence of a member of the Environmental Assessment Board. The purpose of the meeting is really to identify issues and seek agreement as to the number of parties, their role at the hearing to obtain some disclosure and exchange documentary evidence. Marginally the pre-hearing conference is seen as a forum for some form of mediation. But essentially the pre-hearing conference is an attempt to shake down the process, so to speak, to identify some of the issues prior to hearing. In practice the only issues that might be settled at this stage would be procedural issues and not substantive issues. However, the model is instructive and echoes the role of the mediator in this paper's model.

The First Meeting. The case officer would be responsible for convening and chairing a first meeting. To this first meeting would be invited all registered objectors and participants as already identified by the Environmental Assessment Board or its equivalent. The case officer would have reviewed the Application and would have a broad understanding of the issues. By the time of the first meeting, all objectors too would be expected to have reviewed the Application and have identified their areas of concern. So the first meeting agenda would be as follows:

1) to identify the nature and position of each party;

2) to identify the size and scope of each party's constituency;

3) to determine the financial resources of each party and their requirement for additional resources to effectively deal with the Application.

Funding and Support. The purpose of the first meeting is critical to the process. It implicitly recognizes that the parties to the process are not equal, that they do not have equal access to resources, either financial or expert. Mediation to be effective must ensure that each party feels that it is able to cogently and intelligently advance proposals in its areas of concern. Each participant must be guaranteed the right to participate effectively in mediation. It must therefore be indicated in the statute or regulations that a preliminary matter to be canvassed by the case officer is the nature of the resources available to the parties to the proceedings. The issue of funding would form the substance of an initial report by the case officer to the Minister.

Funding would occur here and not at the hearing stage.

Haussmann contends that five criteria must be met to determine if a dispute has potential for resolution by mediation. These are:

1) the parties have a stake in the outcome;

2) all parties must be willing to enter into mediation in good faith;

3) the mediator must have the complete trust of the parties;

4) Government authorities must provide reasonable assurances that they will cooperate with mediation; (underlining mine)

5) the issues under dispute must be amenable to a compromised solution.

Government A Party. In the model proposed in this paper, conditions 1, 2, 4 and 5 can be met by ensuring at the beginning of mediation that all parties will be able to participate equally in the process. The process, while starting with mediation, will most likely come to a hearing at a later stage. Critics may argue that it is inappropriate to consider funding at this stage owing to the fact that intervenor funding is a matter for separate application to the Board. In actual practice, funding is granted by the Ministry. The initial mediation meeting by the case officer, in my view, would ensure that the funds are available at the earliest possible opportunity. The Government having funded the activities of interest groups at this time will be committed to ensuring that the mediation process has a fair chance of being effective. In case it is not absolutely clear, the Ministry of the Environment will be a party to the mediation just as it is a party to an Environmental Hearing. Its support of and participation in the mediation process is as critical as the participation of any other party. The Government would be expected to behave in mediation like any other party. There will be issues on which the Government will be required to take a position different than the one it would intend to advance at a hearing. It is important to realise that in any mediation model the Government must behave with some flexibility otherwise the exercise will fail. The Government cannot hope to achieve any concensus building on Environmental issues if it insists on maintaining rigid non-compromising positions on the matters present in an application. Finally, a conciliatory attitude by the Government and the applicant will act as an incentive to other parties to view the process as essentially one of compromise and conciliation. Dogmatic and rigid view points that characterize Environmental Hearings cannot be present in mediation.

The stake of the Applicant will be insured by its being required to subsidize the funding.

At this point, therefore, to summarize the following has been established. First, the legislative basis has been created which explicitly states that the Government sees mediation as having a useful function in the Environmental process. Second, the Government has recruited a body of persons who have the requisite skills to act as case officers/mediators. Third, the case officer will begin his functions by ensuring that all the parties who will be taking part in the process are able to participate on an equal footing. This means funding will be available and distributed before substantive mediation talks begin.

## TIMING

One of the qualifications of mediation is to reduce time spent at a hearing and in appropriate cases eliminate a hearing. In mediation, time is of the essence. The first mediation meeting should convene within three weeks of the filing of an application. This would ensure ample time for the Registrar of the Environmental Hearing Board to identify or contact interested parties. Upon the proper application by any party, it could be made a party to the mediation if it were not made a party initially. All parties would be required to attend the first meeting armed with some information about their available resources and their need for additional resources. The case officer would make his recommendations to the Minister within fourteen days of the meeting. Funding and other resources would have to be made available within a reasonable time thereafter, perhaps another two weeks, leaving a month for the parties to prepare themselves for the actual substantive meetings in mediation. Therefore, the substantive talks should begin two months after the preliminary meeting or at the most, three months. While these delays may appear lengthy, the Environmental Assessment Board cannot schedule hearing dates any earlier than three to five months from the filing of the Application. On difficult matters, hearing dates are usually scheduled six months from the date of filing. In terms of expedition, the pre-hearing waiting time can well be utilized by the mediation process.

## SUBSTANTIVE MEDIATION POWERS AND DUTIES

There are numerous ways in which a mediator can carry out his role. This paper will not identify any particular technique of mediation. It has been assumed throughout that there is a need for mediation in the environmental process; that it is considered desirable by the parties. Further, it is assumed that those chosen to act as mediators will possess the requisite skills to carry out their duties. Nevertheless, a few major features of the mediation process can be described:

1. The case officer/mediator shall have the power to meet individually or collectively with parties as he deems necessary.

2. The case officer/mediator may present suggestions or alternatives for consideration for the parties.

3. The case officer/ mediator shall be responsible for the preparation of any agenda for a meeting.

4. The case officer/mediator shall have the power to schedule meetings, insist that parties attend meetings, adjourn meetings, set deadlines and control communications between the parties.

5. The case officer/mediator shall be the only person involved in the process to speak to the media.

6. The case officer shall have primary responsibility for drafting a settlement document.

7. The case officer/mediator shall, when he considers the process to be completed or if he believes no useful purpose will be served by continuing the process, report to the Minister.

The "Process". To begin the process, the mediator will likely establish a framework agreement to govern procedural matters. With this completed, the mediator will begin a series of individual and collective meetings with the parties. There obviously will be a number of mechanical problems associated with the process, depending on the number of parties, such as meeting facilities, the place of meetings and so on. I would envisage a "Kissinger" type shuttle mediation where the mediator initially does most of the moving about. It is his skill and initiative which will allow the parties to be brought together when he deems the time ripe for a face to face meeting. Through his early meetings with the parties, the mediator will begin to familiarise himself with the issues and will advance modified positions for the parties in areas where conflict is evident. He will attempt at this stage to bring the parties as close together as possible before they engage in face to face discussions. It will be up to the case officer to be satisfied that the parties are reviewing and dealing with issues from an equal base of technical expertise. While there are models of mediation where a great deal of discretion is left with the mediator regarding the provision of outside assistance to less sophisticated parties, under this model, with its preliminary meeting and the subsequent funding of parties, it is anticipated that no party will be under-represented or at a resource disadvantage at the negotiating sessions.

Interim Agreements. As mediation continues the case officer should "sign off" on any interim or preliminary agreements. Each item of agreement that can be ratified during the process should be, rather than leaving all agreements to be ratified at the end.

The mediator should be satisfied that any compromise or settlement achieved during the process is explained by the parties' representatives to their constituencies. Nothing is more frustrating nor indeed more common, than to have representatives achieve a solution at the table only to find that his position is rejected by his constituents. The reason for this is that the constituents and the representatives have not established an effective method of communicating. The mediator will have to ensure thatthe parties have established their own internal system of decision making before the mediation process begins.

Time Limits. The mediator should be given power to decide how long he thinks it advisable to continue the mediation process. There is an initial time limitation in the statute as indicated earlier in the paper, but with a near absolute right to extend any time period at the instance of the mediator. It is important for him to be able to show to the parties that the process cannot continue forever. Unless some real progress is being made, he may suspend mediation. This power would ensure that no party abuses the process by engaging in sham negotiations.

Concerns. There are a few readily identifiable problem areas in the mediation process that have to be considered. Must agreement on all issues be unanimous? Can minority positions be reported to the Minister? Can a mediator deal directly with a party as opposed to a party's representative? The answers to these questions are not clear. Furthermore, it is probably not profoundly distressing that they remain unclear at this time. It is inappropriate to impose too many conditions or restrictions on the process. For instance in so far as unanimity is concerned there may be issues which only affect a few of the parties to the process. It would be holding the process up to blackmail if a party that had no interest in a particular issue could nevertheless block a resolution by casting a negative vote. One of the ways of dealing with this matter is to force the parties to line up on issues and declare their interest in one of the preliminary meetings. This would avoid the problem of "bushwacking" by a party whose true interest is to delay any resolution. By way of editorial comment, my experience in the process of mediation and negotiations over the years suggests that it is not unlikely that there would be parties who see delay as a desirable result. It is problematical whether mediation would be appropriate if such were discovered to be the case. In any event, for the purposes of this paper, its assumed that all parties are interested in achieving a solution.

## HEARING AND POST-HEARING MEDIATION

A further and helpful feature of the proposed model is that the mediator will continue his duties through the hearing and post hearing stages of the application. Insofar as the hearing stage is concerned, as evidence unfolds, the parties may be able to better assess their positions and decide on further compromise. For this reason, the case officer/mediator would remain assigned to the particular application and would be available to meet with the parties on an ongoing basis outside the scope of the hearing to attempt to achieve further consensus and agreement on issues. The parties themselves could report to the Board on the results of their efforts in this regard. This concept is a hybrid borrowing from the mediator involved in collective agreement negotiations and from the field officer of the Labour Board involved in unfair labour practice complaints. In unfair labour practice cases, the parties are advised that the field officer is available to confer with the parties during the hearing. This availability, in many cases, facilitates further settlement of issues. I submit the concept has merit in mediation.

Finally, there is need to ensure that agreements and understandings reached during the mediation process continue after an approval is granted. Typically, compromises and agreements reached during mediation will be embodied in the final decision of the Board or the certificate issued by the Minister in each case in the form of conditions. It is not suggested that the case officer will have any power at this stage to enforce terms. That is for the parties to do themselves. However, the case officer will be available at the request of any party to convene a meeting or take part in meetings that are contemplated by the Certificate to ensure that the relationship established in mediation continues to thrive in the post-hearing period. Because the relationship between the parties in an environmental matter may be ongoing, continued involvement of the officer may be appropriate. This continuing role will be a significantly reduced one and may involve only his being a meeting convener. It is anticipated that he would have no further involvement with the parties a year after a final decision has been rendered by the Board.

Throughout the entire process it is expected that the Government will provide all the necessary funds and resources to support the case officers efforts.

## CONCLUSION

Most of us who have participated in environmental hearings are sensitive to the length and complexity of these hearings. It is astonishing to note how little disclosure or dialogue takes place between the parties at any stage of the process. During the actual hearing, little if any time is spent in settlement discussions. It is submitted that the mediation process would be cost effective by reducing the length and expense of Environmental Assessment hearings. While there will be many time-consuming technical issues encountered in mediation such as amendments to the original application as filed, and consideration of amended or modified time saving proposals will be achieved. The mediation process is not intended to totally surplant the hearing process. The Hearing should be reserved for those issues that are truly contentious and require evidence and argument in order for a final position to be established. The less contentious matters can and should be dealt with in mediation. While the government and applicant have a financial or other tangible commitment to the process, the model does not envisage a financial state for objectors. Because of the funding process, it is difficult to envisage any situation where there would be a downside risk to objectors. However, to the extent an objector acted irresponsibly or arbitrarily in mediation, this could have an effect on subsequent funding or other resource support to that party.

This then is the model of environmental medition that I submit should be explored. Absent a statutory framework to the process, I do not believe mediation as presently envisaged will succeed or thrive. This paper only addresses environmental diation but it should be apparent to any observer that the regulatory framework of environmental assessment and license granting needs a complete overhaul. Too much authority and power is left to administrative officials or to a Board that operates within a skeletal legislative framework. What is needed ultimately is a complete re-evaluation of the environmental assessment process to ensure that all the parts work harmoniously and effectively.

# COMMUNICATION AND MEDIA

Calgary Herald

Mark Lowey, Reporter

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